1984

RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT

FOR

THREE MILE ISLAND NUCLEAR STATION

Prepared by

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SUMMARY

This report contains the results of the Radiological Environmental Monitoring Program (REMP) conducted by the GPU Nuclear Environmental Controls Department around Three Mile Island Nuclear Station (TMINS) during the period of January 1 through December 31, 1984. This program complies with the United States Nuclear Regulatory Commission (USNRC) requirements of the Technical Specifications (TS) for TMI-1 and TMI-2 (1, 2). It can be concluded from the results of the REMP that TMINS had no adverse impact on the environment during this period. Similar conclusions were reached in previous reports, with the exception of 1979 when transient low-level increases of iodine-131 (I-131) and gamma immersion dose were evidenced in the immediate environment as a result of the TMI-2 accident. Various studies such as the Kemeny Commission Report (3), Rogovin Report (4), and the Ad Hoc Interagency Report (5) concluded that the radioactive releases from the accident had negligible effects on the health of individuals residing in the TMI vicinity.

During 1984 there were 1,634 main program samples and 428 quality control samples taken from the aquatic (water), atmospheric (air), and terrestrial (land) environments around TMINS. Continuous environmental radiation dose measurements, using thermoluminescent dosimeters (TLDs), were obtained at 73 locations during the first quarterly period and at 86 locations for the remaining quarterly periods of 1984 yielding a total of 1,456 analyses, 149 of which were quality control. The results of all TS sample analyses are included in this report.

Based on the comparisons of values from stations which could be affected

by station operations (indicator) and those which are expected to be unaffected (control), investigations were initiated to determine the cause of the differences between various data sets during 1984. Results of these investigations demonstrated that sources other than TMINS were responsible for the differences noted.

Strontium-90 (Sr-90), cesium-137 (Cs-137), and tritium (H-3) were routinely detected in various media throughout 1984. However, their presence is not unexpected since all three radionuclides are produced in relatively large amounts and ubiquitously distributed in the biosphere as a result of nuclear detonations in the atmosphere. Although no atmospheric nuclear tests have been recorded since 1980, the persistence of these radionuclides in the environment is a result of their relatively long half-lives. Tritium is also produced continuously in the atmosphere by cosmic rays.

Iodine-131 was sporadically detected in water samples. Its occurrence was related to diagnostic and radiotherapy procedures performed at nearby medical facilities.

The direct radiation immersion dose measurements utilizing TLDs and the real time gamma radiation monitoring system indicated levels consistent with atmospheric fallout and natural background environmental radiation.

The sample locations chosen and analyses performed on the various media were adequate for detecting any environmental perturbation, whether TMINS related or externally caused, for all significant exposure pathways to man. No environmental perturbations were noted in 1984.

Radionuclides detected in the environment were compared to radionuclides from plant effluents for purposes of determining plant impacts on the environment. Neither TMI-1 nor TMI-2 have been operational since 1979, therefore, no additional fission products have been generated since that time. Most of the short-lived radionuclides such as I-131 have decayed and are no longer present in plant effluents. Gaseous and liquid effluent monitoring data from TMI-1 and TMI-2 for 1984 were analyzed. As a result of this analysis, the maximum hypothetical doses received by an individual from both liquid and gaseous effluents were below the USNRC permissible yearly dose limits. Compliance with the United States Environmental Protection Agency (USEPA) 25 mrem/year total body and 25 mrem/year organ dose limits was also demonstrated.

Based on the groundwater data collected from monitoring locations on TMI during 1984, H-3 was the only radionuclide consistently detected in any of the sampling stations. Pre-1984 leaks from the TMI-2 Borated Water Storage Tank (BWST) were responsible for the elevated H-3 concentrations in the immediate vicinity of the TMI-2 Reactor Building. Since mid-1982, H-3 concentrations in samples obtained from stations in the TMI-2 BWST vicinity have trended downward. Based on hydrogeologic data for the TMI site, groundwater stored within TMI poses no contamination threat to domestic wells. As a result, no adverse effects on the groundwater quality outside of TMI was evidenced. The natural hydrologic cycle, combined with long groundwater transport times, also prevented any TMI groundwater contamination from adversely affecting the Susquehanna River.

Analysis and interpretation of the 1984 environmental monitoring data indicates that no individual received a radiation exposure significantly different from natural background contributions. It is concluded that TMINS did not produce any adverse changes in the levels of environmental radioactivity.

CONCLUSIONS

The REMP conducted from January 1 through December 31, 1984, was performed in accordance with the Technical Specifications for TMI-1 and TMI-2. The objectives of the program as defined in Section 3.1, were met. All data were reviewed by the Environmental Controls Department for GPU Nuclear to assess all significant environmental pathways.

Strontium-90, Cs-137, H-3 and I-131 were detected in various media during the monitoring period. However, their presence was not attributable to TMINS operations.

The exposure from ambient gamma radiation, as measured by thermoluminescent dosimeters, averaged 60.1 mrem and showed no evidence of a TMINS contribution during the 1984 monitoring period. For purposes of comparison the estimated radiation dose to the general populace due to exposure from artificial and natural sources is presented in the following table (6):

Source of Exposure	Annual Dose in mrem/yr
Medical	78
Cosmic Radiation	28
External Terrestrial	26
Radionuclides in the Body (K-40)	19
Global Fallout	4
Total	155

It can be concluded from the 1984 monitoring program that activities related to the operations of TMI-1 and TMI-2 did not alter or adversely affect the radiological characteristics of the environs. Furthermore, the radionuclides and radiation levels observed were due to natural background radioactivity, residual global fallout, and other users of radionuclides.

1.0 INTRODUCTION

With the exception of medical uses, radiation from natural sources in the environment is the major source of exposure to man. The world population is bathed in radiation from the sun and from naturally occurring radioactive materials in the earth's crust.

These radionuclides were created at the beginning of the universe. Some atoms were created with an excess of energy. These atoms are referred to as radioactive, because they dissipate their excess energy by expelling particles from their atomic centers. In so doing, they spontaneously change their chemical identity and become stable. Radionuclides undergo this decay process at a rate which is different for each isotope. This characteristic decay time is referred to as the half-life. Some isotopes have a half-life as short as a fraction of a second while others have half-lives as long as millions of years. The radioactive materials found in the earth's crust today consist of isotopes which had half-lives long enough to enable them to survive the billions of years since the formation of our planet. Important examples of such isotopes are potassium-40 (K-40), uranium-238 (U-238), and thorium-232 (Th-232). Upon decay, the latter two isotopes change into atoms which are also radioactive. So U-238 and Th-232 are just the first step in a complex series of decays which ultimately end with different isotopes of lead. These radionuclides are introduced into the aquatic, terrestrial, and atmospheric environments by such natural processes as volcanic action, weathering and erosion. The interaction of cosmic rays with atoms in the earth's atmosphere produces other radionuclides such as beryllium-7 (Be-7), beryllium-10 (Be-10), carbon-14 (C-14), tritium (H-3), and sodium-22 (Na-22). Portions of these so called cosmogenically produced radionuclides become deposited on land and water surfaces while the remainder stay suspended in the atmosphere. Thus, there are radioactive materials in the ground we stand on, in the air we breathe, and in the food and water we consume. In fact, our own bodies contain radioactive materials such as K-40. The radiation exposure levels experienced by man fluctuate with time and also can vary widely from location to location. The following table lists several locations and their exposure rates from natural radionuclides in soil (7):

Location	Exposure Rate (mR/yr)
Clallam Bay, Washington	24
"Typical" for U.S.A.	60
Denver, Colorado	114
Atypically high local sites	
Kerala, India	1,600
Black Forest, Germany	1,800
Central City, Colorado	2,200
Guarapari, Brazil	17,000
U.S.S.R.	70,000

Man also contributes to the radioenvironment through such activities as medical, scientific and industrial uses of radionuclides, nuclear weapons testing, and nuclear power generation. Although they have no control over natural sources, national and international agencies set limits to minimize the exposure caused by human endeavors.

Nuclear fission is a process in which heavy atoms such as uranium are split into lighter fragments, many of which are radioactive. This process also results in the release of large amounts of energy. When the energy is released at a controlled rate, man can use the fission process to generate electricity. The same process is used in a nuclear weapon, but the energy is released at an uncontrolled rate. Nuclear reactors cannot produce explosions like nuclear bombs because their uranium fuel does not have the high degree of purity that is required.

Fallout refers to the radioactive debris that settles to the surface of the earth following the explosion of nuclear weapons. Fallout can be washed down to the earth's surface by rain or snow. There are approximately 200 radionuclides produced in the fission process, but only a few of these appear in fallout. The radionuclides found in fallout which are most likely to result in radiation exposures to man are I-131, strontium-89 (Sr-89), Sr-90 and Cs-137. Iodine-131, which has an eight-day half-life is the radionuclide that produces the greatest radiation exposure within a short time after a nuclear detonation. This is because relatively large amounts of I-131 are produced when nuclear weapons are detonated. Iodine may produce areas of varying contamination because it is deposited in a spotty fashion. If it is transmitted through the food chain, it will become concentrated in the thyroid gland of humans. Two radioisotopes of strontium are also produced by nuclear explosions: Sr-90 with a half-life of 28 years, and Sr-89 with a half-life of 51 days. Strontium-90 represents the greatest potential long-term exposure. In the body, it moves with calcium and is incorporated into the bones where it remains as an internal source of radiation because of its long half-life. Strontium-90 reaches man primarily through consumption of dairy products and garden produce. Cesium-137 has a half-life of 30 years and behaves in much the same way as potassium does in biological systems. Direct contamination of plant materials is the most important pathway to man. The biological effect of Cs-137 is less than that of Sr-90 because it is eliminated from the body more rapidly.

Radionuclides are used for medical purposes such as diagnostics and treatment. Common biomedical isotopes include I-131, technitium-99m (Tc-99m), and Xenon-133 (Xe-133). Generally, these radionuclides have very short half-lives or are rapidly eliminated from the body.

Radionuclides found in effluents from nuclear power generating facilities include all of the fission products mentioned in connection with weapons fallout. In conducting the environmental monitoring program for a nuclear power plant, one must try to determine what portion of the fission products found in the environment was due to the operation of the nuclear facility and what portion was attributable to other sources such as fallout. In the operation of a nuclear reactor, certain elements become radioactive when they are bombarded by neutrons liberated in the fission process. Isotopes of iron, manganese and cobalt are in this category. Minute quantities of these activation products may also be present in the effluents of nuclear power plants. The environmental impact of these activation products must also be assessed.

Any mechanism that can supply the energy necessary to ionize an atom, break a chemical bond or alter the chemistry of a living cell is capable of producing biological damage. The particles emitted when radioactive nuclei decay can produce cellular damage by any of these mechanisms. In terms of energy, a four-ounce tennis ball and a four-ounce chunk of glass traveling 30 miles per hour are identical. To a physician, who has to repair the damage incurred when these objects strike a person, they produce quite different effects. An analogous situation exists for radiation. In assessing the effects of radiation, the type of particles emitted, the energy of the particles and the number of particles must all be considered. When dealing with environmental radioactivity, there are three principle kinds of radiation: alpha particles, beta particles, and gamma rays. Alpha particles are helium nuclei consisting of two protons and two neutrons bound together as a unit. Beta particles are high-speed electrons. Gamma rays are high energy electromagnetic waves, similar in many ways to light waves. All three are capable of producing cellular damage in varying degrees. The number of particles emitted by a radioactive source is described by a unit called the "curie." A one-curie radioactive source emits 37 billion particles per second; but in the realm of environmental radioactivity, this is a rather large unit. So, two fractional units--the microcurie and the picocurie--are more commonly used. The microcurie is one millionth of a curie and represents 37,000 decays per second. The picocurie is one millionth of the microcurie and represents 0.037 particle emissions per second. Since modern radiation measuring instruments are sensitive enough to detect extremely small quantities of radioactive material, these fractional units are more useful.

The unit used to indicate biological damage produced by radiation is the rem. This unit accounts for the type of particle as well as its energy. Here again, a fractional unit--the millirem--is used because it is more convenient. The millirem (abbreviated mrem) represents one thousandth of a rem. Exposure to radiation is said to result in a dose. It is impossible to avoid all radiation because everyone is routinely exposed to the variety of natural and man-made radiation sources discussed above. A coast-to-coast jet flight will expose the passengers to approximately five mrem. Living in Denver, Colorado, as opposed to Harrisburg, Pennsylvania, will result in an additional 70 mrem/yr exposure because there is less atmosphere shielding the residents from the sun's cosmic rays. A single chest X-ray can deliver a dose as high as 50 mrem to the patient. The doses resulting from various sources of natural and man-made radiation are listed in the Conclusion section.

Regulatory Guide 4.1 (8), of the United States Nuclear Regulatory Commission, sets forth guidelines for monitoring radioactivity in the environs of nuclear power plants. Criteria presented in this document include data gathering requirements relative to the preoperational environmental status of the power plant site and further establishes a monitoring program pertinent to the operational phase of the plant.

Metropolitan Edison initiated a preoperational Radiological Environmental Monitoring Program (REMP) around the Three Mile Island area in 1968 which continued until June 1974 when initial criticality for

TMI-1 was achieved. From June 1974 to the present, the REMP has been considered to be in the operational phase pursuant to USNRC Regulatory Guide 4.1 for both TMI-1 and TMI-2. GPU Nuclear assumed responsibility for the operation of TMINS from Metropolitan Edison Company in 1981. Since that time the REMP has been maintained and operated by the GPU Nuclear Environmental Controls Department .

On March 28, 1979, an accident in the TMI-2 reactor resulted in a cessation of operation which has continued through the present 1984 investigational period. A major step in the cleanup of TMI-2 was accomplished in 1984. In July, the head of the reactor vessel was lifted in preparation for fuel removal in the latter part of 1985. TMI-1, which had been out of service for purposes of refueling at the time of the TMI-2 accident, has remained out of service through the investigational period. Data on the preoperational as well as operational phases prior to 1984 have been presented in previous documents (References 9-20).

This report presents data, sample descriptions and results generated by the TMINS REMP for the period of January 1, 1984 through December 31, 1984.

2.0 GENERAL SITE INFORMATION

2.1 General Information

Three Mile Island is located in the Susquehanna River approximately 2.5 miles south of the Borough of Middletown and 10 miles southeast of Harrisburg. Information relative to the plant site description, geology, hydrology, climatology, terrestrial and aquatic environs is presented in the 1981 Annual REMP Report (18) and the respective Final Safety Analysis Reports for TMI-1 and TMI-2 (21, 22).

2.2 Climatological Summary - 1984*

Monthly average temperatures during 1984 were below normal for January, March, April, May, July, and September. Above normal monthly average temperatures were reported for February, June, August, October, and December. November's monthly average temperature was normal. The average monthly temperature over the year ranged from 24.8°F in January to 75.8°F in August. The lowest temperature of -9°F occurred on January 22, while the highest temperature of 96°F was recorded on June 10.

Total precipitation for the year was measured at 44.05 inches or about 8 inches above the normal annual average. The monthly precipitation totals range from a low of 1.12 inches in January to 6.36 inches in June. The largest precipitation event occurred on May 29 when 1.85 inches of rain fell. The heaviest snowfall was

* Source: United States National Weather Service. Local Climatological Data, Harrisburg, Pennsylvania

measured on March 29 when an accumulation of 6.7 inches was recorded.

A wind rose and joint frequency tables for the TMI site are provided in Appendix K and are generated from onsite meteorological data.

3.0 PROGRAM

3.1 Objectives

The objectives of the operational Radiological Environmental Monitoring Program are:

1. To fulfill the obligation of the Radiological Environmental Surveillance Monitoring Program as specified in the Technical Specifications for TMI-1 and TMI-2 (1, 2).
2. To determine whether any significant increases in the environmental concentrations of radionuclides have occurred in critical transport pathways to humans.
3. To detect the buildup of reactor produced long-lived radionuclides in the environment.
4. To detect any change in ambient gamma radiation levels resulting from plant operations.
5. To determine if TMINS operations have had any adverse effects on the health and safety of the public or on the environment.

3.2 Design

In order to meet the program objectives, an operational REMP was developed. Critical pathway analysis for the operational REMP requires that samples be taken from the aquatic, atmospheric, and terrestrial environments. Samples of various environmental media are selected to obtain data for the evaluation of potential radiation dose to individuals and/or populations around TMINS. Sample types are based on 1) established critical pathways for the transfer of radionuclides through the environment to the population, and 2) experience gained during the preoperational and prior operational phases. Sampling locations were determined from site meteorology, Susquehanna River hydrology, local demography and land use.

Sampling locations are divided into two classes: indicator and control. Indicator stations are those locations which are expected to manifest plant effects, if any exist; control stations are those locations which should be unaffected by station operations. Fluctuations in the levels of radionuclides and direct radiation at indicator stations were evaluated with respect to analogous fluctuations at control stations. Data were also evaluated relative to characteristics established prior to plant operations and previous operational phases. Additional samples beyond those required by the Technical Specifications were collected and analyzed. Results are included and presented with the Technical Specification data in this report.

The analysis of environmental samples and the analytical data generated were routinely evaluated by the TMINS Environmental Controls staff. The USNRC establishes levels at which reports must be submitted when environmental radioactivity concentrations are exceeded. The TMI Environmental Controls staff conducts investigations of anomalous concentrations at levels well below USNRC reporting requirements. If it has been determined that investigational levels have been reached as defined in Appendix D, followup actions are initiated to verify results and to identify potential sources and consequences. These actions may include recounts, reanalysis, and/or collection of additional samples.

Further review of the program and analytical data were performed by laboratories under contract to GPU Nuclear. The analytical procedures and quality control methods utilized by the REMP analytical laboratory are detailed in references 23, 24, and 25 and are also described in Appendix E. The quality assurance (QA) program for the TMI REMP is implemented by 1) auditing contractor laboratories, 2) requiring contractor laboratories to participate in the United States Environmental Protection Agency (USEPA) Cross-Check Program, 3) requiring contractor laboratories to split samples for separate analysis (recounts are performed when samples are not able to be split) and 4) Environmental Controls routinely splitting samples, having the samples analyzed by independent laboratories, and then comparing the results for agreement. The QA program and the results of the USEPA Cross-Check Program are outlined in Appendix E and F, respectively.

The REMP is audited by the USNRC and GPU Nuclear Quality Assurance department.

Table 1 summarizes the Three Mile Island Nuclear Station's operational REMP. Appendix A presents the sample coding system which specifies sample type and relative locations. Table A-1 gives the individual sampling locations, while Figures A-1, A-2, and A-3 depict their geographical locations.

TABLE 1

SYNOPSIS OF THE OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

FOR THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Number of Sampling Locations	Collection Frequency	Number of Samples Collected	Type of Analysis	Analysis Frequency	Number of Samples Analyzed *
Surface/Drinking Water	13	Weekly	101	I-131	Weekly Composite or Grab	101
(Including Station Intakes)		Biweekly	432	I-131	Biweekly Composite or Grab	432
				P-32	Biweekly Composite or Grab	21
				Gr-α	Monthly Composite	18
				Gr-β	Monthly Composite	222
				Gamma	Monthly Composite	222
				H-3	Monthly Composite	222
				P-32	Monthly Composite	18
				Fe-55	Monthly Composite	18
				Sr-89	Quarterly Composite	74
				Sr-90	Quarterly Composite	74
Discharge Water	1	Weekly	9	I-131	Weekly Composite or Grab	9
		Biweekly	48	I-131	Biweekly Composite or Grab	48
				Gr-α	Monthly Composite	24
				Gr-β	Monthly Composite	24
				H-3	Monthly Composite	24
				P-32	Biweekly Composite or Grab	48
				P-32	Monthly Composite	24
				Fe-55	Monthly Composite	24
				γ Scan	Monthly Composite	24

TABLE 1 (continued)

SYNOPSIS OF THE OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

FOR THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Number of Sampling Locations	Collection Frequency	Number of Samples Collected	Type of Analysis	Analysis Frequency	Number of Samples Analyzed *
Discharge Water (cont'd)	1			Sr-89	Quarterly Composite	8
				Sr-90	Quarterly Composite	8
Air Particulate	8	Weekly	530	Gr-α	Weekly Composite	70
				Gr-β	Weekly Composite	530
				Gamma	Monthly Composite	120
				Gr-α	Quarterly Composite	40
				Sr-89	Quarterly Composite	40
				Sr-90	Quarterly Composite	40
Air Iodine	8	Weekly	530	I-131	Weekly Composite	530
Precipitation	5	Monthly	84	Gr-β	Monthly Composite	84
				Gamma	Quarterly Composite	28
				H-3	Quarterly Composite	28
				Sr-89	Semiannual Composite	14
				Sr-90	Semiannual Composite	14
Milk	8	Semimonthly	259	I-131	Semimonthly Composite	259
				Gamma	Semimonthly Composite	259
				Gamma	Monthly Composite	20
				Sr-89	Quarterly Composite	40
				Sr-90	Quarterly Composite	40

TABLE 1 (continued)

SYNOPSIS OF THE OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

FOR THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Number of Sampling Locations	Collection Frequency	Number of Samples Collected	Type of Analysis	Analysis Frequency	Number of Samples Analyzed *
Fish	2	Semiannually	12	Gamma	Semiannual Composite	12
				Sr-89	Semiannual Composite	12
				Sr-90	Semiannual Composite	12
Aquatic Sediment	3	Semiannually	8	Gamma	Semiannual Composite	8
				Sr-89	Semiannual Composite	8
				Sr-90	Semiannual Composite	8
Aquatic Plants	2	Semiannually	5	Sr-89	Semiannual Composite	5
				Sr-90	Semiannual Composite	5
				Gamma	Semiannual Composite	5
Green Leafy Vegetation and Vegetables	6	Annually	13	I-131	Annual Composite	13
				Gamma	Annual Composite	13
Fruits	4	Annually	5	I-131	Annual Composite	5
				Gamma	Annual Composite	5
Soil	11	Semiannually	26	Gamma	Semiannual Composite	26
				Sr-89	Semiannual Composite	26
				Sr-90	Semiannual Composite	26

TABLE 1 (continued)

SYNOPSIS OF THE OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

FOR THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Number of Sampling Locations	Collection Frequency	Number of Samples Collected	Type of Analysis	Analysis Frequency	Number of Samples Analyzed *
Dosimeters (TLD)	86	Quarterly	1456	Gamma Immersion Dose	Quarterly	1456

* Number of samples analyzed does not include duplicate analyses, recounts, or reanalyses.

NOTE: The number of samples collected is a combination of base and Q.C. REMP

3.4 Deviations to the 1984 REMP

The operational REMP for TMI-1 and TMI-2 was conducted in accordance with its respective Technical Specifications. Changes to the REMP are described in Appendix C. The TS require a minimum number of samples to be collected and that analysis of these samples meet certain analytical sensitivities, i.e., lower limit of detection (LLD). Table 2 presents problems encountered in atmospheric, terrestrial, and aquatic sample collection. Sample analyses which did not meet the required analytical sensitivity are presented in Appendix B. Since the TMINS REMP exceeds the minimum requirements for sample collection and analysis, none of these deviations resulted in failure to comply with the Technical Specifications.

TABLE 2

DEVIATIONS IN THE SAMPLING PROGRAM DURING 1984*

January 12, 1984	Frozen compositor lines at water stations A3-2, G15-2, J1-2. Grab samples taken.
January 19, 1984	Frozen compositor lines at water stations A3-2, J2-1, G15-2. Grab samples taken.
January 26, 1984	Frozen compositor lines at water stations A3-2, J2-1. Grab samples taken.
January 26, 1984	Compositor malfunction at water station K1-1Q (discharge). Insufficient volume for quality control sample.
February 19, 1984	Frozen compositor lines at water station A3-2, J2-1. Grab samples taken.
April 12, 1984	Compositor malfunction at water station H5-2F. Grab sample taken.
April 14, 1984	Sample line blocked at water station A3-2. Grab sample taken. Technical malfunction at water station Q9-1R. Grab Sample taken.
June 27, 1984	TLD station L15-1 vandalized. No TLD's recovered.
September 27, 1984	TLD stations H8-1, J7-1, L15-1 and M2-1 totally or partially vandalized.
October 14, 1984	Milk sample at station P4-1 was unavailable.
October 18, 1984	No aquatic vegetation was found at the indicator station.
December 31, 1984	TLD stations K5-1 and Q15-2 were partially vandalized.

* Refer to Appendix A, Table A-1 for station description.

4.0 RESULTS AND DISCUSSION

The averages and ranges of detectable analytical results from the 1984 REMP are summarized in Table 3. Results for each type of sample taken were grouped according to the analysis performed and segregated by indicator and control stations. Where applicable, the location with the highest annual mean for a particular analysis is presented in Table 4. To eliminate biases in the statistics, quality control results were excluded from both tables. In cases where a sample was recounted or reanalyzed, that result was used. Refer to Appendix N for an explanation of data analysis.

4.1 Aquatic Environment

4.1.1 Surface/Drinking Water

For the first quarter of 1984, surface and drinking water samples were collected from 16 locations on the Susquehanna River and its tributaries. Thereafter the sampling regime was reduced to 15 stations. At 12 of the sampling locations automatic water compositors were used to gather samples, while at two drinking water stations technicians prepared hourly aliquots. All samples were picked up on a biweekly schedule except for those listed in Table 2. Additionally, a weekly sample was collected to closeout a quarterly composite period. At one location, Chickies Creek (F15-1), biweekly grab samples were taken. A total of 438 surface and drinking water samples (excluding quality

TABLE 3

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations Mean**	Indicator Locations Range**	Indicator Locations No. of LLDs/ Analyses	Indicator Locations No. of Positives/ Analyses	Control Locations Mean**	Control Locations Range**	Control Locations No. of LLDs/ Analyses	Control Locations No. of Positives/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Surface Water	I-131	pCi/L	1.0	1.77	0.24-8.6	141/147	6/147	0.62	0.22-2.8	110/123	13/123	0
	H-3	pCi/L	2000	131	50-680	5/60	55/60	120	50-370	4/51	47/51	0
	Gr-β	pCi/L	4.0	5.3	1.4-19.0	1/60	59/60	5.9	1.8-34.0	1/51	50/51	0
	Sr-89	pCi/L	1.0	---	---	20/20	0/20	---	---	17/17	0/17	0
	Sr-90	pCi/L	1.0	---	---	20/20	0/20	---	---	17/17	0/17	0
	Mn-54	pCi/L	15.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Fe-59	pCi/L	30.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Co-58	pCi/L	15.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Co-60	pCi/L	15.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Zn-65	pCi/L	30.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Zr-95	pCi/L	30.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Nb-95	pCi/L	15.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Cs-134	pCi/L	15.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Cs-137	pCi/L	18.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	Ba-140	pCi/L	60.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	La-140	pCi/L	15.0	---	---	60/60	0/60	---	---	51/51	0/51	0
	K-40	pCi/L	80.0	---	---	60/60	0/60	101	101	50/51	1/51	0
Drinking Water	I-131	pCi/L	1.0	---	---	113/113	0/113	---	---	56/56	0/56	0
	H-3	pCi/L	2000	119	40-620	3/48	45/48	161	40-810	4/24	20/24	0
	Gr-β	pCi/L	4.0	2.9	1.3-5.5	10/48	38/48	2.9	1.3-6.1	2/24	22/24	0
	Sr-89	pCi/L	1.0	---	---	16/16	0/16	---	---	8/8	0/8	0
	Sr-90	pCi/L	1.0	---	---	16/16	0/16	---	---	8/8	0/8	0
	Mn-54	pCi/L	15.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Fe-59	pCi/L	30.0	---	---	48/48	0/48	---	---	24/24	0/24	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations				Control Locations				No. of USNRC Nonroutine Reportable Measurements
				Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	
Drinking Water (cont'd)	Co-58	pCi/L	15.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Co-60	pCi/L	15.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Zn-65	pCi/L	30.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Zr-95	pCi/L	30.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Nb-95	pCi/L	15.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Cs-134	pCi/L	15.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Cs-137	pCi/L	18.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	Ba-140	pCi/L	60.0	---	---	48/48	0/48	---	---	24/24	0/24	0
	La-140	pCi/L	15.0	---	---	48/48	0/48	---	---	24/24	0/24	0
Effluent Water	I-131	pCi/L	1.0	0.46	0.36-0.56	27/29	2/29	---	---	---	---	0
	H-3	pCi/L	2000	142	70-340	1/12	11/12	---	---	---	---	0
	Gr-β	pCi/L	4.0	4.8	3.4-7.2	1/12	11/12	---	---	---	---	0
	Sr-89	pCi/L	1.0	---	---	12/12	0/12	---	---	---	---	0
	Sr-90	pCi/L	1.0	---	---	12/12	0/12	---	---	---	---	0
	Mn-54	pCi/L	15.0	---	---	12/12	0/12	---	---	---	---	0
	Fe-59	pCi/L	30.0	---	---	12/12	0/12	---	---	---	---	0
	Co-58	pCi/L	15.0	---	---	12/12	0/12	---	---	---	---	0
	Co-60	pCi/L	15.0	---	---	12/12	0/12	---	---	---	---	0
	Zn-65	pCi/L	30.0	---	---	12/12	0/12	---	---	---	---	0
	Zr-95	pCi/L	30.0	---	---	12/12	0/12	---	---	---	---	0
	Nb-95	pCi/L	15.0	---	---	12/12	0/12	---	---	---	---	0
	Cs-134	pCi/L	15.0	---	---	12/12	0/12	---	---	---	---	0
	Cs-137	pCi/L	18.0	---	---	12/12	0/12	---	---	---	---	0
	Ba-140	pCi/L	60.0	---	---	12/12	0/12	---	---	---	---	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations				Control Locations				No. of USNRC Nonroutine Reportable Measurements
				Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	
Effluent Water (cont'd)	La-140	pCi/L	15.0	---	---	12/12	0/12	---	---	---	---	0
	P-32	pCi/L	5.0	---	---	20/20	0/20	---	---	---	---	0
	Fe-55	pCi/L	50.0	---	---	12/12	0/12	---	---	---	---	0
	Gr-Alpha	pCi/L	5.0	---	---	12/12	0/12	---	---	---	---	0
	K-40	pCi/L	80.0	63	26-99	10/12	2/12	---	---	---	---	0
Fish	Sr-89	pCi/gm (wet)	0.025	---	---	4/4	0/4	---	---	4/4	0/4	0
	Sr-90	pCi/gm (wet)	0.005	0.020	0.017-0.022	2/4	2/4	0.012	0.010-0.014	2/4	2/4	0
	Mn-54	pCi/gm (wet)	0.13	---	---	4/4	0/4	---	---	4/4	0/4	0
	Fe-59	pCi/gm (wet)	0.26	---	---	4/4	0/4	---	---	4/4	0/4	0
	Co-58	pCi/gm (wet)	0.13	---	---	4/4	0/4	---	---	4/4	0/4	0
	Co-60	pCi/gm (wet)	0.13	---	---	4/4	0/4	---	---	4/4	0/4	0
	Zn-65	pCi/gm (wet)	0.26	---	---	4/4	0/4	---	---	4/4	0/4	0
	Cs-134	pCi/gm (wet)	0.13	---	---	4/4	0/4	---	---	4/4	0/4	0
	Cs-137	pCi/gm (wet)	0.15	0.039	0.008-0.071	1/4	3/4	0.012	0.010-0.014	2/4	2/4	0
	K-40	pCi/gm (wet)	0.80	3.1	2.9-3.3	0/4	4/4	3.0	2.8-3.3	0/4	4/4	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

				Indicator Locations				Control Locations				
Sample Type	Analysis	Unit	Lower Limit of Detection*	Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Aquatic Plants	Sr-89	pCi/gm (wet)	0.05	---	---	1/1	0/1	---	---	2/2	0/2	0
	Sr-90	pCi/gm (wet)	0.025	---	---	1/1	0/1	0.002	0.002	1/2	1/2	0
	Mn-54	pCi/gm (wet)	0.13	---	---	1/1	0/1	---	---	2/2	0/2	0
	Fe-59	pCi/gm (wet)	0.26	---	---	1/1	0/1	---	---	2/2	0/2	0
	Co-58	pCi/gm (wet)	0.13	---	---	1/1	0/1	---	---	2/2	0/2	0
	Co-60	pCi/gm (wet)	0.13	---	---	1/1	0/1	---	---	2/2	0/2	0
	Zn-65	pCi/gm (wet)	0.26	---	---	1/1	0/1	---	---	2/2	0/2	0
	Cs-134	pCi/gm (wet)	0.13	---	---	1/1	0/1	---	---	2/2	0/2	0
	Cs-137	pCi/gm (wet)	0.15	0.044	0.044	0/1	1/1	---	---	2/2	0/2	0
	K-40	pCi/gm (wet)	0.80	3.3	3.3	0/1	1/1	2.7	1.7-3.8	0/2	2/2	0
	Be-7	pCi/gm (wet)	0.80	0.20	0.20	0/1	1/1	0.27	0.18-0.36	0/2	2/2	0
	Th-228	pCi/gm (wet)	0.80	---	---	1/1	0/1	0.36	0.36	0/2	2/2	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations				Control Locations				No. of USNRC Nonroutine Reportable Measurements
				Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	
Aquatic Sediment	Sr-89	pCi/gm (dry)	0.10	---	---	4/4	0/4	---	---	2/2	0/2	0
	Sr-90	pCi/gm (dry)	0.05	---	---	4/4	0/4	---	---	2/2	0/2	0
	Cs-134	pCi/gm (dry)	0.15	---	---	4/4	0/4	---	---	2/2	0/2	0
	Cs-137	pCi/gm (dry)	0.18	0.38	0.20-0.52	0/4	4/4	0.19	0.14-0.24	0/2	2/2	0
	Be-7	pCi/gm (dry)	0.10	2.0	1.8-2.2	2/4	2/4	0.95	0.78-1.11	0/2	2/2	0
	Th-228	pCi/gm (dry)	0.10	1.3	0.9-1.6	0/4	4/4	1.3	1.0-1.7	0/2	2/2	0
	K-40	pCi/gm (dry)	0.10	11.3	6.6-16.1	0/4	4/4	9.9	8.0-11.8	0/2	2/2	0
	Ra-226	pCi/gm (dry)	0.10	2.3	1.4-2.9	0/4	4/4	1.9	1.7-2.1	0/2	2/2	0
Precipitation	Gr-β	pCi/L	0.7	2.9	0.9-8.4	0/36	36/36	2.6	0.7-5.9	0/24	24/24	0
	H-3	pCi/L	200	143	97-240	3/12	9/12	88	70-100	2/8	6/8	0
	Sr-89	pCi/L	5.0	---	---	6/6	0/6	---	---	4/4	0/4	0
	Sr-90	pCi/L	1.0	---	---	6/6	0/6	---	---	4/4	0/4	0
	Mn-54	pCi/L	15.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	Fe-59	pCi/L	30.0	---	---	12/12	0/12	---	---	8/8	0/8	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations: Mean**	Indicator Locations: Range**	Indicator Locations: No. of LLDs/ Analyses	Indicator Locations: No. of Positives/ Analyses	Control Locations: Mean**	Control Locations: Range**	Control Locations: No. of LLDs/ Analyses	Control Locations: No. of Positives/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Precipitation (cont'd)	Co-58	pCi/L	15.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	Co-60	pCi/L	15.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	Zn-65	pCi/L	30.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	ZrNb-95	pCi/L	10.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	Cs-134	pCi/L	15.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	Cs-137	pCi/L	15.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	BaLa-140	pCi/L	15.0	---	---	12/12	0/12	---	---	8/8	0/8	0
	Be-7	pCi/L	50.0	---	---	12/12	0/12	56.1	56.1	7/8	1/8	0
Air Iodine	I-131	pCi/M^3	0.07	---	---	265/265	0/265	---	---	159/159	0/159	0
Air Particulates	Gr-β	pCi/M^3	0.01	0.016	0.004-0.043	2/265	263/265	0.016	0.005-0.033	3/159	156/159	0
	Sr-89	pCi/M^3	0.0005	---	---	20/20	0/20	---	---	12/12	0/12	0
	Sr-90	pCi/M^3	0.0003	0.00033	0.00033	19/20	1/20	0.00028	0.00025-0.00030	10/12	2/12	0
	Gr-α	pCi/M^3	0.001	0.0025	0.0014-0.0038	0/20	20/20	0.0023	0.0011-0.0039	0/12	12/12	0
	Be-7	pCi/M^3	0.50	0.084	0.039-0.140	0/60	60/60	0.084	0.029-0.120	0/36	36/36	0
	K-40	pCi/M^3	0.10	0.021	0.016-0.029	55/60	5/60	0.017	0.013-0.022	33/36	3/36	0
	Cs-134	pCi/M^3	0.05	---	---	60/60	0/60	---	---	36/36	0/36	0
	Cs-137	pCi/M^3	0.06	0.0064	0.0012-0.0130	55/60	5/60	0.0032	0.0014-0.0063	29/36	7/36	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations				Control Locations				No. of USNRC Nonroutine Reportable Measurements
				Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	
Immersion Dose	Gamma	mrem/ std mo	Per USNRC Reg. Guide	4.9	2.8-9.2	---	---	5.5	3.6-8.0	---	---	0
Milk (Cow)	I-131	pCi/L	1.0	---	---	129/129	0/129	---	---	26/26	0/26	0
	Sr-89	pCi/L	5.0	---	---	25/25	0/25	---	---	5/5	0/5	0
	Sr-90	pCi/L	2.0	2.2	0.7-4.5	0/25	25/25	2.7	2.0-3.1	0/5	5/5	0
	Cs-134	pCi/L	15.0	---	---	129/129	0/129	---	---	26/26	0/26	0
	Cs-137	pCi/L	14.0	---	---	129/129	0/129	---	---	26/26	0/26	0
	Ba-140	pCi/L	60.0	---	---	129/129	0/129	---	---	26/26	0/26	0
	La-140	pCi/L	15.0	---	---	129/129	0/129	---	---	26/26	0/26	0
	K-40	pCi/L	80.0	1300	610-1600	0/129	129/129	1390	1190-1560	0/26	26/26	0
Milk (Goat)	I-131	pCi/L	1.0	---	---	26/26	0/26	---	---	26/26	0/26	0
	Sr-89	pCi/L	5.0	---	---	5/5	0/5	---	---	5/5	0/5	0
	Sr-90	pCi/L	2.0	3.7	1.5-5.2	0/5	5/5	3.7	1.7-6.1	0/5	5/5	0
	Cs-134	pCi/L	15.0	---	---	26/26	0/26	---	---	26/26	0/26	0
	Cs-137	pCi/L	14.0	11.0	9.2-12.7	24/26	2/26	---	---	26/26	0/26	0
	Ba-140	pCi/L	60.0	---	---	26/26	0/26	---	---	26/26	0/26	0
	La-140	pCi/L	15.0	---	---	26/26	0/26	---	---	26/26	0/26	0
	K-40	pCi/L	80.0	1590	1200-2020	0/26	26/26	1780	1480-2090	0/26	26/26	0
Fruits	I-131	pCi/gm (wet)	0.06	---	---	3/3	0/3	---	---	1/1	0/1	0
	Cs-134	pCi/gm (wet)	0.06	---	---	3/3	0/3	---	---	1/1	0/1	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations Mean**	Indicator Locations Range**	Indicator Locations No. of LLDs/ Analyses	Indicator Locations No. of Positives/ Analyses	Control Locations Mean**	Control Locations Range**	Control Locations No. of LLDs/ Analyses	Control Locations No. of Positives/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Fruits (cont'd)	Cs-137	pCi/gm (wet)	0.08	---	---	3/3	0/3	---	---	1/1	0/1	0
	K-40	pCi/gm (wet)	0.40	1.9	0.9-3.1	0/3	3/3	1.8	1.8	0/1	1/1	0
Vegetables	I-131	pCi/gm (wet)	0.06	---	---	4/4	0/4	---	---	1/1	0/1	0
	Cs-134	pCi/gm (wet)	0.06	---	---	4/4	0/4	---	---	1/1	0/1	0
	Cs-137	pCi/gm (wet)	0.08	---	---	4/4	0/4	---	---	1/1	0/1	0
	K-40	pCi/gm (wet)	0.40	2.7	2.2-3.5	0/4	4/4	2.6	2.6	0/1	1/1	0
Broad Leaf Vegetation	I-131	pCi/gm (wet)	0.06	---	---	3/3	0/3	---	---	1/1	0/1	0
	Cs-134	pCi/gm (wet)	0.06	---	---	3/3	0/3	---	---	1/1	0/1	0
	Cs-137	pCi/gm (wet)	0.08	0.013	0.013	2/3	1/3	---	---	1/1	0/1	0
	K-40	pCi/gm (wet)	0.40	3.6	2.3-4.7	0/3	3/3	4.9	4.9	0/1	1/1	0
	Be-7	pCi/gm (wet)	0.10	0.24	0.14-0.33	1/3	2/3	0.34	0.34	0/1	1/1	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 3 (Cont'd)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL SAMPLES FROM

THREE MILE ISLAND NUCLEAR STATION

1984

Sample Type	Analysis	Unit	Lower Limit of Detection*	Indicator Locations				Control Locations				No. of USNRC Nonroutine Reportable Measurements
				Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	Mean**	Range**	No. of LLDs/ Analyses	No. of Positives/ Analyses	
Soil	K-40	pCi/gm (dry)	0.1	10.7	5.8-24.5	0/14	14/14	24.3	12.5-57.8	0/8	8/8	0
	Sr-90	pCi/gm (dry)	0.15	0.054	0.011-0.160	6/14	8/14	0.087	0.030-0.150	5/8	3/8	0
	Cs-137	pCi/gm (dry)	0.15	0.30	0.11-0.66	0/14	14/14	0.61	0.30-1.09	0/8	8/8	0
	Ra-226	pCi/gm (dry)	0.1	2.1	1.1-3.0	0/14	14/14	2.2	1.7-2.8	0/8	8/8	0
	Th-228	pCi/gm (dry)	0.1	1.2	0.8-1.6	0/14	14/14	1.5	1.2-1.8	0/8	8/8	0

* Technical Specification LLDs are given when applicable. It should be noted that TMI REMP uses lower limits of detection than required.

** Mean and Range based upon detectable values only from main program (does not include QC Results).

TABLE 4

SAMPLING LOCATIONS BY MEDIA WITH THE HIGHEST ANNUAL MEAN

1984

Sample Type	Analysis	Name	Distance and Direction*	Mean**	Range**	Units	No. of LLD/ Analyses	No. of Pos/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Surface Water	I-131	J2-1 W. Shore of TMI at Dam	1.5 mi. S. of TMI	3.05	0.24-8.6	pCi/L	29/32	3/32	0
	H-3	J1-2 W. Shore of TMI	0.5 mi. S. of TMI	165	100-330	pCi/L	2/12	10/12	0
	Gr-β	F15-1 Chickies Creek	12.6 mi. ESE of TMI	10.1	5.0-34.0	pCi/L	0/12	12/12	0
	Sr-89	---	---	---	---	pCi/L	---	---	0
	Sr-90	---	---	---	---	pCi/L	---	---	0
	Mn-54	---	---	---	---	pCi/L	---	---	0
	Fe-59	---	---	---	---	pCi/L	---	---	0
	Co-58	---	---	---	---	pCi/L	---	---	0
	Co-60	---	---	---	---	pCi/L	---	---	0
	Zn-65	---	---	---	---	pCi/L	---	---	0
	Zr-95	---	---	---	---	pCi/L	---	---	0
	Nb-95	---	---	---	---	pCi/L	---	---	0
	Cs-134	---	---	---	---	pCi/L	---	---	0
	Cs-137	---	---	---	---	pCi/L	---	---	0
	Ba-140	---	---	---	---	pCi/L	---	---	0
	La-140	---	---	---	---	pCi/L	---	---	0
	K-40	A3-2 Swatara Creek	2.5 mi. N. of TMI	101	101	pCi/L	11/12	1/12	0
Drinking Water	I-131	---	---	---	---	pCi/L	---	---	0
	H-3	J15-2 York Water Works	14.7 mi. S. of TMI	170	70-810	pCi/L	1/12	11/12	0
	Gr-β	G15-2 Wrightsville Water Works	13.6 mi. SE. of TMI	3.6	2.4-5.5	pCi/L	1/12	11/12	0
	Sr-89	---	---	---	---	pCi/L	---	---	0
	Sr-90	---	---	---	---	pCi/L	---	---	0
	Mn-54	---	---	---	---	pCi/L	---	---	0
	Fe-59	---	---	---	---	pCi/L	---	---	0
	Co-58	---	---	---	---	pCi/L	---	---	0
	Co-60	---	---	---	---	pCi/L	---	---	0
	Zn-65	---	---	---	---	pCi/L	---	---	0

* Distance measured from the reactor complex centerline.

** Mean and Range based upon detectable values only from main program (does not include QC results).

TABLE 4 (continued)

SAMPLING LOCATIONS BY MEDIA WITH THE HIGHEST ANNUAL MEAN

1984

Sample Type	Analysis	Name	Distance and Direction*	Mean**	Range**	Units	No. of LLD/ Analyses	No. of Pos/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Drinking Water (cont'd)	Zr-95	---	---	---	---	pCi/L	---	---	0
	Nb-95	---	---	---	---	pCi/L	---	---	0
	Cs-134	---	---	---	---	pCi/L	---	---	0
	Cs-137	---	---	---	---	pCi/L	---	---	0
	Ba-140	---	---	---	---	pCi/L	---	---	0
	La-140	---	---	---	---	pCi/L	---	---	0
Fish	Sr-89	---	---	---	---	pCi/gm (wet)	---	---	0
	Sr-90	Indicator	Downstream of TMI Discharge	0.020	0.017-0.022	pCi/gm (wet)	2/4	2/4	0
	Mn-54	---	---	---	---	pCi/gm (wet)	---	---	0
	Fe-59	---	---	---	---	pCi/gm (wet)	---	---	0
	Co-58	---	---	---	---	pCi/gm (wet)	---	---	0
	Co-60	---	---	---	---	pCi/gm (wet)	---	---	0
	Zn-65	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-134	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-137	Indicator	Downstream of TMI Discharge	0.039	0.008-0.071	pCi/gm (wet)	1/4	3/4	0
	K-40	Indicator	Downstream of TMI Discharge	3.1	2.9-3.3	pCi/gm (wet)	0/4	4/4	0

* Distance measured from the reactor complex centerline.
** Mean and Range based upon detectable values only from main program (does not include QC results).

TABLE 4 (continued)

SAMPLING LOCATIONS BY MEDIA WITH THE HIGHEST ANNUAL MEAN

1984

Sample Type	Analysis	Name	Distance and Direction*	Mean**	Range**	Units	No. of LLD/ Analyses	No. of Pos/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Aquatic Plants	Sr-89	---	---	---	---	pCi/gm (wet)	---	---	0
	Sr-90	Control	Upstream of TMI Discharge	0.002	0.002	pCi/gm (wet)	1/2	1/2	0
	Mn-54	---	---	---	---	pCi/gm (wet)	---	---	0
	Fe-59	---	---	---	---	pCi/gm (wet)	---	---	0
	Co-58	---	---	---	---	pCi/gm (wet)	---	---	0
	Co-60	---	---	---	---	pCi/gm (wet)	---	---	0
	Zn-65	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-134	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-137	Indicator	Downstream of TMI Discharge	0.044	0.044	pCi/gm (wet)	0/1	1/1	0
	K-40	Indicator	Downstream of TMI Discharge	3.3	3.3	pCi/gm (wet)	0/1	1/1	0
	Be-7	Control	Upstream of TMI Discharge	0.27	0.18-0.36	pCi/gm (wet)	0/2	2/2	0
	Th-228	Control	Upstream of TMI Discharge	0.36	0.36	pCi/gm (wet)	1/2	1/2	0
Aquatic Sediment	Sr-89	--	---	---	---	pCi/gm (dry)	---	---	0
	Sr-90	---	---	---	---	pCi/gm (dry)	---	---	0
	Cs-134	---	---	---	---	pCi/gm (dry)	---	---	0

* Distance measured from the reactor complex centerline.
** Mean and Range based upon detectable values only from main program (does not include QC results).

TABLE 4 (continued)

SAMPLING LOCATIONS BY MEDIA WITH THE HIGHEST ANNUAL MEAN

1984

Sample Type	Analysis	Name	Distance and Direction*	Mean**	Range**	Units	No. of LLD/ Analyses	No. of Pos/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Aquatic Sediment (cont'd)	Cs-137	J2-1 (Indicator)	1.5 mi. S. of TMI	0.51	0.51-0.52	pCi/gm (dry)	0/2	2/2	0
	Be-7	J2-1 (Indicator)	1.5 mi. S. of TMI	2.0	1.8-2.2	pCi/gm (dry)	0/2	2/2	0
	Th-228	J2-1 (Indicator)	1.5 mi. S. of TMI	1.6	1.5-1.6	pCi/gm (dry)	0/2	2/2	0
	K-40	J2-1 (Indicator)	1.5 mi. S. of TMI	15.5	14.8-16.1	pCi/gm (dry)	0/2	2/2	0
	Ra-226	J2-1 (Indicator)	1.5 mi. S. of TMI	2.9	2.9-2.9	pCi/gm (dry)	0/2	2/2	0
Precipitation	Gr-β	E1-2 Observation Center	0.4 mi. E. of TMI	4.2	1.1-8.4	pCi/L	0/12	12/12	0
	H-3	A3-1 Middletown	2.6 mi. N. of TMI	170	130-240	pCi/L	1/4	3/4	0
	Sr-89	---	---	---	---	pCi/L	---	---	0
	Sr-90	---	---	---	---	pCi/L	---	---	0
	Mn-54	---	---	---	---	pCi/L	---	---	0
	Fe-59	---	---	---	---	pCi/L	---	---	0
	Co-58	---	---	---	---	pCi/L	---	---	0
	Co-60	---	---	---	---	pCi/L	---	---	0
	Zn-65	---	---	---	---	pCi/L	---	---	0
	ZrNb-95	---	---	---	---	pCi/L	---	---	0
	Cs-134	---	---	---	---	pCi/L	---	---	0
	Cs-137	---	---	---	---	pCi/L	---	---	0
	BaLa-140	---	---	---	---	pCi/L	---	---	0
	Be-7	G10-1 Drager Farm	9.8 mi. SE of TMI	56.1	56.1	pCi/L	3/4	1/4	0
Air Iodine	I-131	---	---	---	---	pCi/M^3		---	0
Air Particulates	Gr-β	A1-1 N. Weather Station	0.4 mi. N. (site)	0.017	0.004-0.043	pCi/M^3	1/53	52/53	0
		H3-1 Falmouth	2.3 mi. SSE (site)	0.017	0.005-0.041	pci/M^3	0/53	53/53	0
	Sr-89	---	---	---	---	pCi/M^3	---	---	0
	Sr-90	A1-1 N. Weather Station	0.4 mi. N. (site)	0.00033	0.00033	pCi/M^3	3/4	1/4	0

* Distance measured from the reactor complex centerline.
** Mean and Range based upon detectable values only from main program (does not include QC results).

TABLE 4 (continued)

SAMPLING LOCATIONS BY MEDIA WITH THE HIGHEST ANNUAL MEAN

1984

Sample Type	Analysis	Name	Distance and Direction*	Mean**	Range**	Units	No. of LLD/ Analyses	No. of Pos/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Air Particulates (cont'd)	Gr-α	A1-1 N. Weather Station	0.4 mi. N. (site)	0.0030	0.0016-0.0038	pCi/M^3	0/4	4/4	0
	Be-7	A1-1 N. Weather Station	0.4 mi. N. (site)	0.091	0.039-0.120	pCi/M^3	0/12	12/12	0
	K-40	H3-1 Falmouth	2.3 mi SSE. of TMI	0.029	0.029	pCi/M^3	11/12	1/12	0
	Cs-134	---	---	---	---	pCi/M^3	---	---	0
	Cs-137	H3-1 Falmouth	2.3 mi. SSE. of TMI	0.013	0.013	pCi/M^3	11/12	1/12	0
Immersion Dose	Gamma	F1-2 Top of Dike	ESE (site)	7.4	6.1-8.2	mrem/ std mo	---	---	0
Milk (Cow)	I-131	---	---	---	---	pCi/L	---	---	0
	Sr-89	---	---	---	---	pCi/L	---	---	0
	Sr-90	A15-1 Oellig Farm	10.5 mi. N. of site	2.7	2.0-3.1	pCi/L	0/5	5/5	0
	Cs-134	---	---	---	---	pCi/L	---	---	0
	Cs-137	---	---	---	---	pCi/L	---	---	0
	Ba-140	---	---	---	---	pCi/L	---	---	0
	La-140	---	---	---	---	pCi/L	---	---	0
	K-40	P7-1 Beshore Farm	6.7 mi. WNW of TMI	1430	1220-1590	pCi/L	0/26	26/26	0
Milk (Goat)	I-131	---	---	---	---	pCi/L	---	---	0
	Sr-89	---	---	---	---	pCi/L	---	---	0
	Sr-90	D15-2 Davidhizer Farm	10.0 mi. ENE of site	3.7	1.7-6.1	pCi/L	0/5	5/5	0
		A2-1 Hardison Farm	1.2 mi. N of TMI	3.7	1.5-5.2	pCi/L	0/5	5/5	0
	Cs-134	---	---	---	---	pCi/L	---	---	0
	Cs-137	A2-1 Hardison Farm	1.2 mi. N of TMI	11.0	9.2-12.7	pCi/L	24/26	2/26	0
	Ba-140	---	---	---	---	pCi/L	---	---	0
	La-140	---	---	---	---	pCi/L	---	---	0
	K-40	D15-2 Davidhizer Farm	10.0 mi. ENE of TMI	1780	1480-2090	pCi/L	0/26	26/26	0

* Distance measured from the reactor complex centerline.
** Mean and Range based upon detectable values only from main program (does not include QC results).

TABLE 4 (continued)

SAMPLING LOCATIONS BY MEDIA WITH THE HIGHEST ANNUAL MEAN

1984

Sample Type	Analysis	Name	Distance and Direction*	Mean**	Range**	Units	No. of LLD/ Analyses	No. of Pos/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Fruits	I-131	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-134	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-137	---	---	---	---	pCi/gm (wet)	---	---	0
	K-40	H1-2 Red Hill Market	0.9 mi. SSE of TMI	3.1	3.1	pCi/gm (wet)	0/1	1/1	0
Vegetables	I-131	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-134	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-137	---	---	---	---	pCi/gm (wet)	---	---	0
	K-40	N4-1 W. Shore Farm	3.7 mi. W of TMI	3.5	3.5	pCi/gm (wet)	0/1	1/1	0
Broad Leaf Vegetables	I-131	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-134	---	---	---	---	pCi/gm (wet)	---	---	0
	Cs-137	D2-1 Alwine Farm	1.1 mi ENE of TMI	0.013	0.013	pCi/gm (wet)	0/1	1/1	0
	K-40	A15-1 Oellig Farm	10.5 mi. N of TMI	4.9	4.9	pCi/gm (wet)	0/1	1/1	0
	Be-7	A15-1 Oellig Farm	10.5 mi. N of TMI	0.34	0.34	pCi/gm (wet)	0/1	1/1	0

* Distance measured from the reactor complex centerline.
** Mean and Range based upon detectable values only from main program (does not include QC results).

TABLE 4 (continued)

SAMPLING LOCATIONS BY MEDIA WITH THE HIGHEST ANNUAL MEAN

1984

Sample Type	Analysis	Name	Distance and Direction*	Mean**	Range**	Units	No. of LLD/ Analyses	No. of Pos/ Analyses	No. of USNRC Nonroutine Reportable Measurements
Soil	K-40	G10-1 Drager Farm	9.8 mi. SE of TMI	47.9	38.0-57.8	pCi/gm (dry)	0/2	2/2	0
	Sr-90	G2-3 Near Conewago Creek	1.6 mi. SE of TMI	0.16	0.16	pCi/gm (dry)	1/2	1/2	0
	Cs-137	Q15-1 West Fairview	13.5 mi. NW of TMI	0.91	0.72-1.10	pCi/gm (dry)	0/2	2/2	0
	Ra-226	G2-3 Near Conewago Creek	1.6 mi. SE of TMI	2.9	2.7-3.0	pCi/gm (dry)	0/2	2/2	0
	Th-228	A9-1 Union Deposit Rd.	9.2 mi. N of TMI	1.7	1.7-1.8	pCi/gm (dry)	0/2	2/2	0

* Distance measured from the reactor complex centerline.
** Mean and Range based upon detectable values only from main program (does not include QC results).

control samples) were collected during 1984. These samples were analyzed for I-131, H-3, gamma-emmitting radionuclides, gross beta activity, and Sr-89 and Sr-90. The results of these analyses demonstrated that TMINS had no detectable effect on the aquatic environment. These results are discussed more fully in the following sections.

Iodine-131

Including duplicate and quality control samples a total of 588 I-131 analyses were performed on surface and drinking water samples during 1984. This isotope appeared sporadically in surface water throughout the sampling period, but it was not detected in any of the drinking water samples. Because its half-life is 8.04 days, and no fission has taken place on TMI for nearly six years, TMINS can be ruled out as the source of this iodine.

For completeness, all positive I-131 values detected in surface water are listed in Table 5. Detectable values for the station discharge, K1-1, are also listed. The designation "dup" in the table denotes a duplicate analysis, i.e., a sample that was split and analyzed by the contractor laboratory as part of its own internal quality assurance program. Locations with a "Q" after the station code designate sampling locations where duplicate samples are prepared for radiological analysis by an independent laboratory.

TABLE 5

POSITIVE RESULTS FOR I-131 ANALYSIS OF WATER+

(pCi/L ± 2σ)

Date	Surface Water: Control Station*	Value	Surface Water: Indicator Station*	Value	Effluent Water: Station*	Value
01/12-01/26	F15-1	.71±.22	G15-1	<0.5	- - -	- - -
	N1-2A	.44±.18	G15-1Q	.29±.13	- - -	- - -
01/19 grab	N1-2B	.49±.15	J2-1	8.6±0.3	- - -	- - -
	N1-2BQ	.55±.22	J2-1Q	8.3±0.3	- - -	- - -
02/09 grab	A3-2	.32±.12	- - -	- - -	- - -	- - -
02/23-03/08	N1-2A	.38±.16	J1-2	.38±.16	K1-1	.56±.19
	N1-2B	.63±.21	dup.	.51±.22	K1-1Q	.45±.17
	N1-2BQ	.38±.13	- - -	- - -	- - -	- - -
03/08-03/22	N1-2A	.62±.12	G15-1	<0.2	- - -	- - -
	N1-2B	.70±.16	G15-1Q	.24±.14	- - -	- - -
	N1-2BQ	.39±.21	dup.	.32±.13	- - -	- - -
04/04-04/12	A3-2	.26±.15	- - -	- - -	- - -	- - -
07/26-08/09	Q9-1	<0.4	- - -	- - -	K1-1	<0.3
	Q9-1Q	.26±.17	- - -	- - -	K1-1Q	.41±.24
08/23-08/30	- - -	- - -	G15-1	<0.3	K1-1	<0.2
	- - -	- - -	G15-1Q	.36±.25	K1-1Q	.41±.29
	- - -	- - -	J2-1	<0.3	- - -	- - -
	- - -	- - -	J2-1Q	.73±.29	- - -	- - -
08/30-09/13	- - -	- - -	- - -	- - -	K1-1	<0.2
	- - -	- - -	- - -	- - -	K1-1Q	.33±.25
	- - -	- - -	- - -	- - -	dup.	<0.3
09/06 grab	- - -	- - -	J2-1	<0.2	- - -	- - -
	- - -	- - -	J2-1Q	.31±.22	- - -	- - -
09/13-09/27	F15-1	2.8±0.3	- - -	- - -	- - -	- - -
	dup.	2.9±0.2	- - -	- - -	- - -	- - -
09/27-10/11	- - -	- - -	- - -	- - -	K1-1	<0.3
	- - -	- - -	- - -	- - -	K1-1Q	.29±.27

TABLE 5 (continued)

POSITIVE RESULTS FOR I-131 ANALYSIS OF WATER⁺

(pCi/L ± 2σ)

	Surface Water				Effluent Water	
Date	Control Station*	Value	Indicator Station*	Value	Station*	Value
10/11-10/25	Q9-1	<0.2	J2-1	<0.3	- - -	- - -
	Q9-1Q	.15±.14	J2-1Q	.52±.11	- - -	- - -
10/25-11/08	N1-2A	.29±.18	G15-1	.76±.16	- - -	- - -
	- - -	- - -	G15-1Q	<0.23	- - -	- - -
	- - -	- - -	J2-1	<0.2	- - -	- - -
	- - -	- - -	J2-1Q	<0.21	- - -	- - -
	- - -	- - -	dup.	.20±.15	- - -	- - -
11/08-11/21	- - -	- - -	G15-1	.34±.13	K1-1	.36±.14
	- - -	- - -	dup.	.40±.14	K1-1Q	<0.40
	- - -	- - -	G15-1Q	<0.50	- - -	- - -
	- - -	- - -	J2-1	.31±.16	- - -	- - -
	- - -	- - -	J2-1Q	.29±.13	- - -	- - -
11/21-11/29	A3-2	.22±.13	J2-1	.24±.12	K1-1	<0.3
			J2-1Q	<0.12	K1-1Q	.32±.28
11/29-12/13	- - -	- - -	- - -	- - -	K1-1	<0.3
	- - -	- - -	- - -	- - -	K1-1Q	.15±.15
12/13-12/27	N1-2A	.25±.14	J1-2	<0.2	- - -	- - -
	dup.	.37±.12	dup.	.29±.15	- - -	- - -

⁺Iodine-131 was not detected in any of the drinking water samples collected during 1984.

*Station Locations

J2-1	West shore TMI at Dam	N1-2B	TMI-2 Intake
J1-2	West shore TMI	N1-2A	TMI-1 Intake
K1-1	TMINS Liquid Discharge (RML-7)	A3-2	Swatara Creek
G15-1	Columbia Water Treatment Plant	F15-1	Chickies Creek
Q9-1	Steelton Water Company		

(R) Raw Water

This is part of the QA program. (The entire program is discussed in Appendix E.) The duplicate and Q values are one means of verifying the original result. They are included in the table for comparison purposes. These additional samples provide a quality assurance check on the original result. Table 5 lists 49 positive I-131 values. This represents only 12 percent of the I-131 analyses performed.

Iodine-131 has several sources in the environment including medical sources, weapons fallout, and nuclear reactors. For these reasons, the occurrence of I-131 in environmental samples was studied to see if it followed any discernable pattern. No spatial or temporal pattern is evident from the table entries. Since no reactor produced iodine has been generated at TMINS for nearly six years, and no nuclear weapons tests have recently been conducted, medical users represent the most probable source of iodine found in these environmental samples.

Tritium

The biweekly surface and drinking water samples were composited for a monthly H-3 analysis for each station. Excluding duplicates and quality control samples, a total of 183 H-3 analyses were performed throughout the year. The vast majority of samples (97 percent) contained H-3 levels within the normal environmental range of 100 pCi/L to

350 pCi/L. Six of the June composite samples were found to contain slightly elevated H-3 concentrations. These samples were obtained from both control and indicator stations. However, all of the downstream stations were effected. Consequently, TMINS was ruled out as the source of this H-3. The elevated values were less than four percent of the NRC reporting level.

Table 6 displays the annual mean and the associated range of H-3 concentrations observed at individual surface and drinking water stations. All of these means were lower than the corresponding values from 1983. The surface water station with the highest annual mean was Station J1-2 on the west shore of TMI. The mean for this indicator station was 165 pCi/L, while the individual monthly values ranged from 100 pCi/L to 330 pCi/L. For comparison, the mean and the range at the highest control station were 141 pCi/L and 70 pCi/L to 370 pCi/L, respectively. These values occurred at the Steelton Water Company (Q9-1), a surface water control station, located nine miles upstream from TMI.

Statistical tests were performed to compare indicator and background surface water H-3 concentrations. These tests revealed that there were no significant differences between the individual stations or between the indicators and controls, each grouped together. The indicator stations had a yearly mean H-3 concentration of 131 $\pm$ 97 pCi/L, while

TABLE 6

ANNUAL AVERAGE TRITIUM CONCENTRATIONS

IN SURFACE AND DRINKING WATER DURING 1984

(pCi/L)

Medium	Station	Description	Annual Average*	Range
SW	A3-2 (C)	Swatara Creek	105	80-160
SW	Q9-1 (C)	Steelton Water Company	141	70-370
SW	N1-2A (C)	TMI-1 Intake	117	50-190
SW	N1-2B (C)	TMI-2 Intake	105	80-130
SW	F15-1 (C)	Chickies Creek	115	50-190
SW	H5-2	Brunner Island	155	70-680
SW	H3-2	York Haven Hydroelectric Generating Station	122	60-420
SW	G15-1	Columbia Water Treatment Plant	117	57-170
SW	J1-2	West shore of TMI	165	100-330
SW	J2-1	West shore of TMI at Dam	105	50-140
DW	Q9-1 (C)	Steelton Water Company	151	40-630
DW	J15-2 (C)	York Water Company	170	70-810
DW	H5-2	Brunner Island	143	60-620
DW	G15-1	Columbia Water Treatment Plant	106	40-210
DW	G15-2	Wrightsville Water Treatment Plant	104	60-210
DW	G15-3	Lancaster Water Treatment Plant	124	54-170

*Based on detectable values only.

SW = Surface Water
DW = Drinking Water
(C) = Control

the control stations had a value of 120 ± 55 pCi/L (± 1 sigma). The similarity between indicators and controls can be seen in Figure 1. Statistical analysis revealed a correlation coefficient of 87 percent between the monthly means at indicator and control stations. No systematic trends are evident from the data displayed in Figure 1. Long term variations in the average H-3 concentration in the Susquehanna River are depicted in Figure 2.

The H-3 concentrations measured in drinking water during 1984 were similar to the values found in surface water. Table 6 lists the mean and the range for individual drinking water stations along with the data for surface water. All the indicator drinking water stations had annual mean H-3 concentrations which were lower than the two control station means. Five out of six of these annual means were lower than the corresponding values from 1983. The highest mean from an indicator station was 143 pCi/L, which occurred at Brunner Island, station H5-2. For comparison, the means at the two drinking water control stations were 170 pCi/L and 151 pCi/L. The single largest H-3 concentration measured all year, 810 pCi/L, occurred at control station J15-2, the York Water Co.

Statistical comparisons were performed on the H-3 data from the drinking water stations. The outcome of these tests was similar to that for the surface water data. That

FIGURE 1

MONTHLY TRITIUM CONCENTRATIONS IN SURFACE WATER

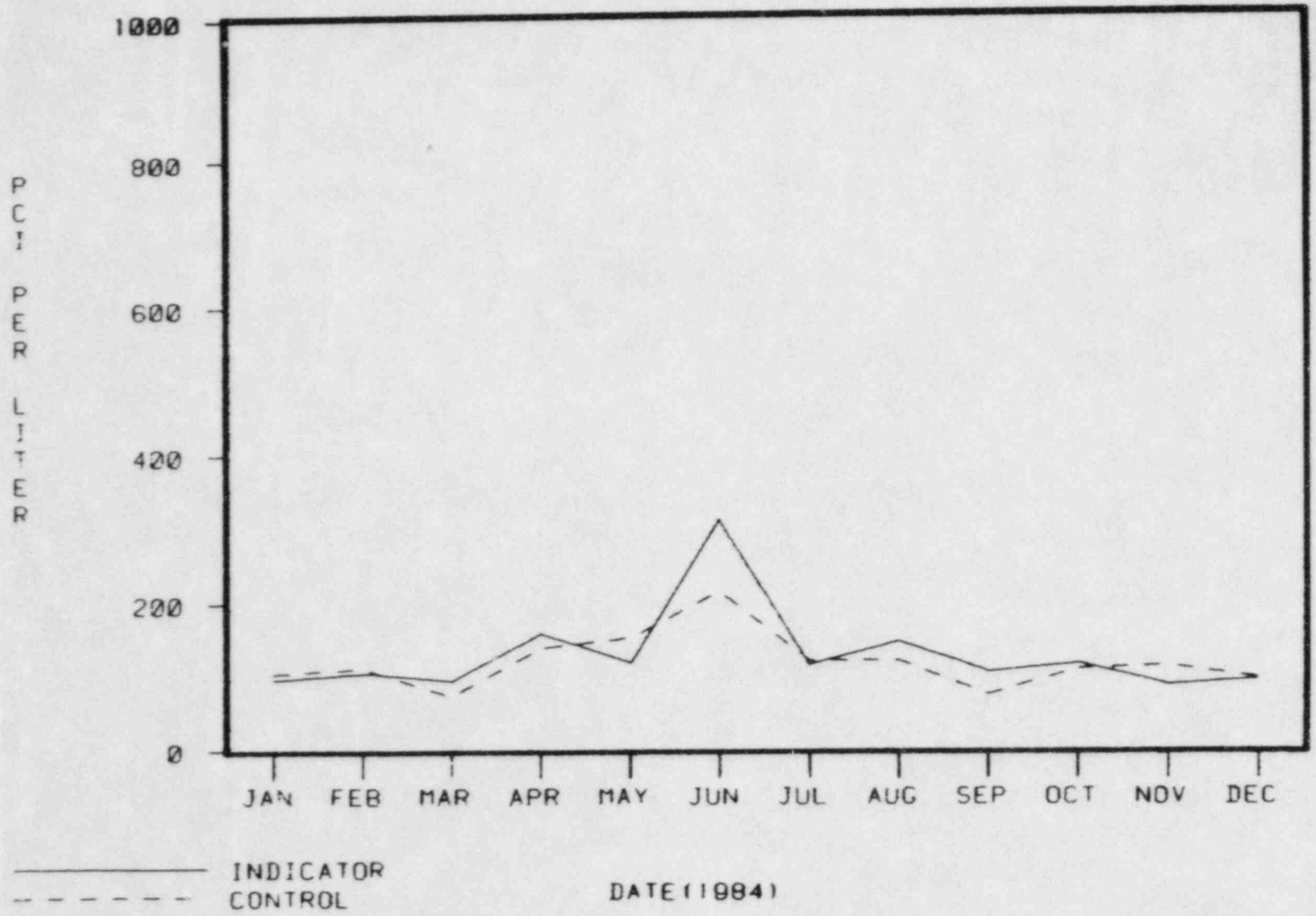
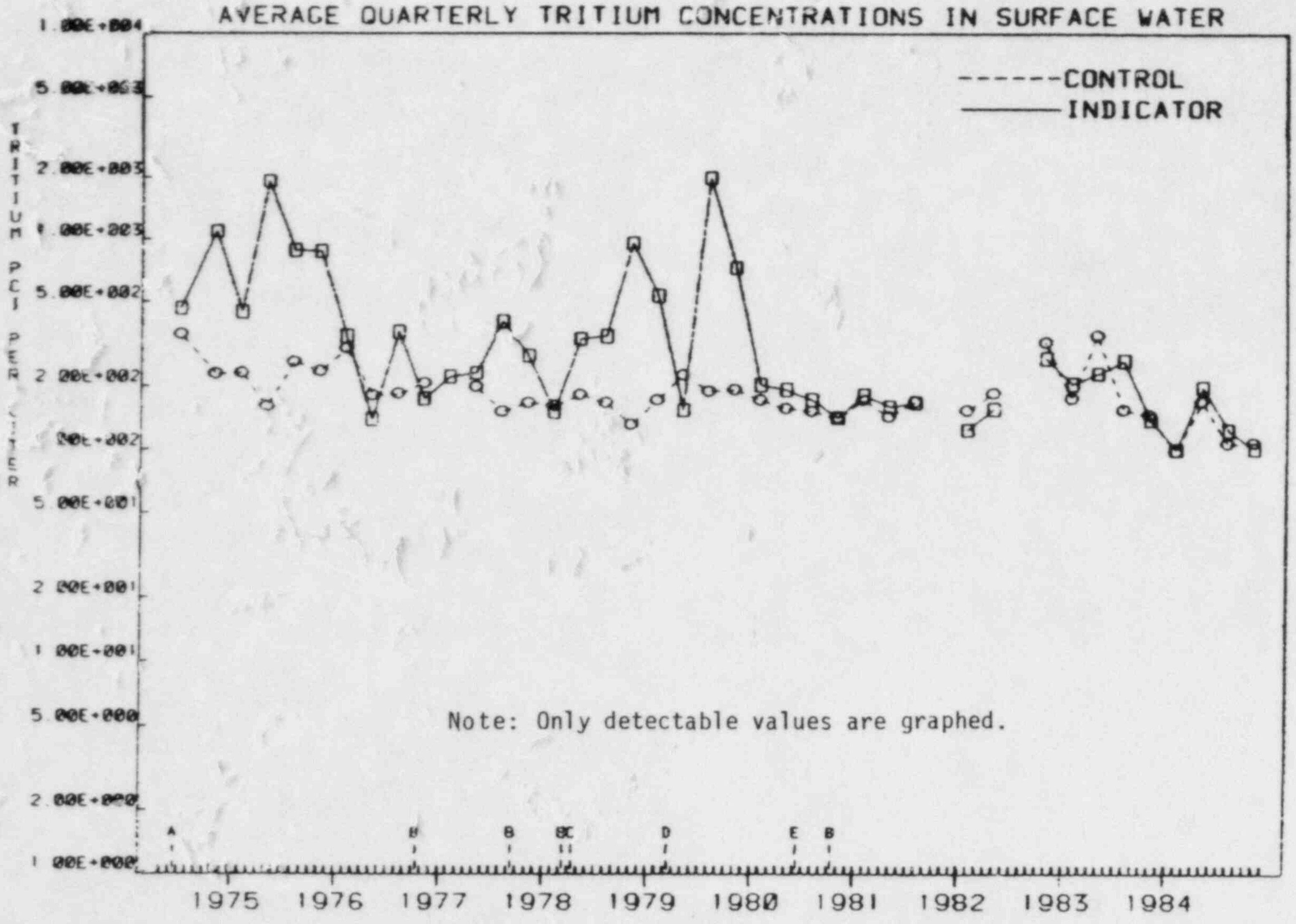


FIGURE 2

AVERAGE QUARTERLY TRITIUM CONCENTRATIONS IN SURFACE WATER



(A) TMI-1 INITIAL CRITICALITY
(B) CHINESE NUCLEAR DETONATION
(C) TMI-2 INITIAL CRITICALITY
(D) TMI-2 ACCIDENT
(E) TMI-2 REACTOR PURGE

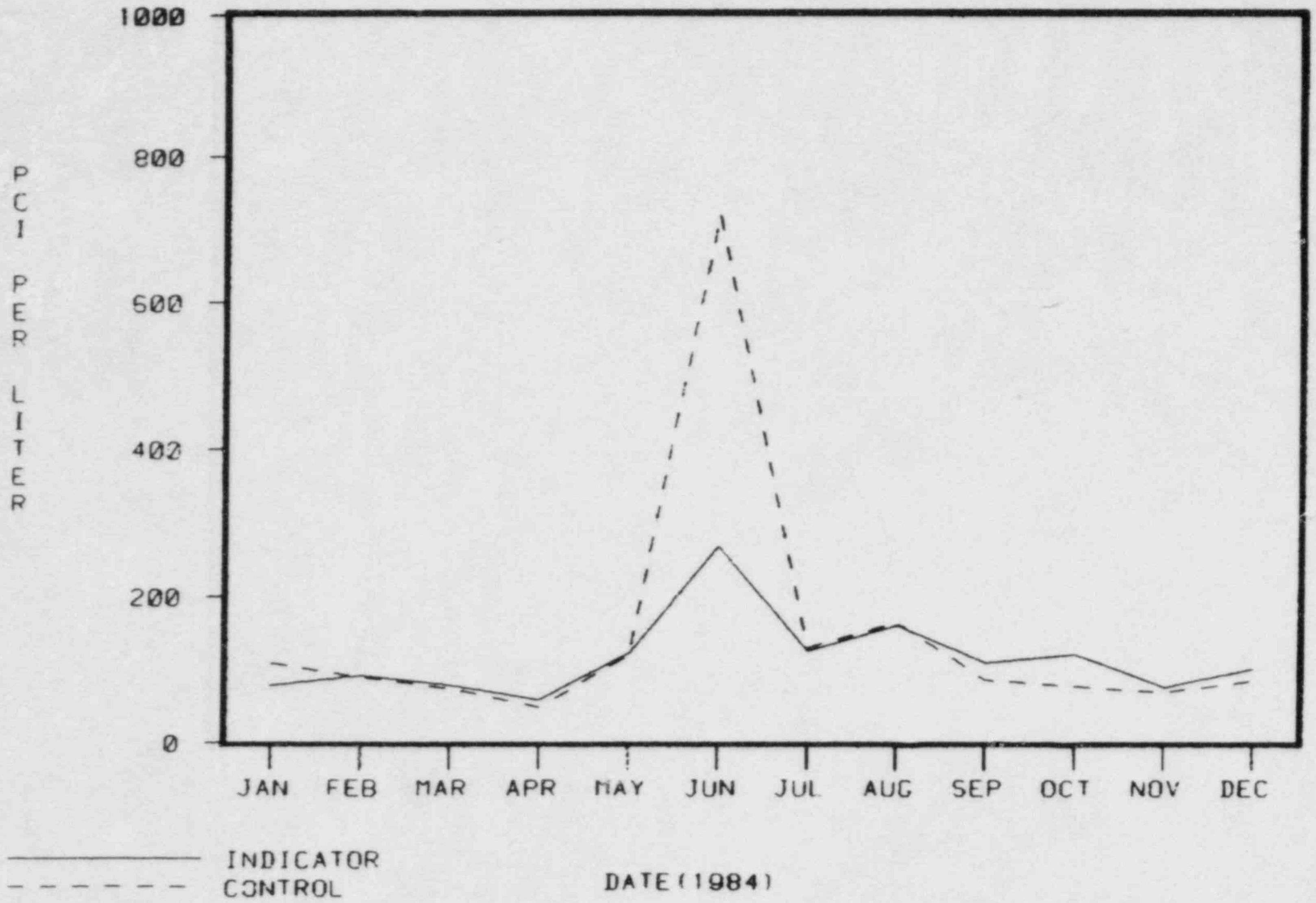
is, an analysis of variance showed that individual drinking water stations, regardless of whether indicator or control, were not significantly different from one another. The indicators as a group were well correlated with the controls. Figure 3 displays the monthly variations of the mean H-3 concentrations for indicator and control drinking water stations. The elevation in the June data appeared in both indicators and controls, but it was more pronounced in the control station data. Consequently, its origin was not related to TMINS operations. There was a 94 percent correlation between the two sets of data. No persistent trends are obvious from the data in Figure 3.

Gross Beta

The gross beta activity in surface and drinking water was determined on a monthly basis from composite samples. Excluding duplicate and quality control samples, one hundred eighty-three (183) gross beta analyses were performed on these media during 1984. This measurement yields only a gross indication of the total radioactivity in a sample. It does not identify specific radionuclides or their relative amounts. Quantitative isotopic information is provided by the other analyses which are performed. Gross beta results are used, however, for comparison purposes and trend analysis. The results of the 1984 gross beta analyses of surface

FIGURE 3

MONTHLY TRITIUM CONCENTRATIONS IN DRINKING WATER

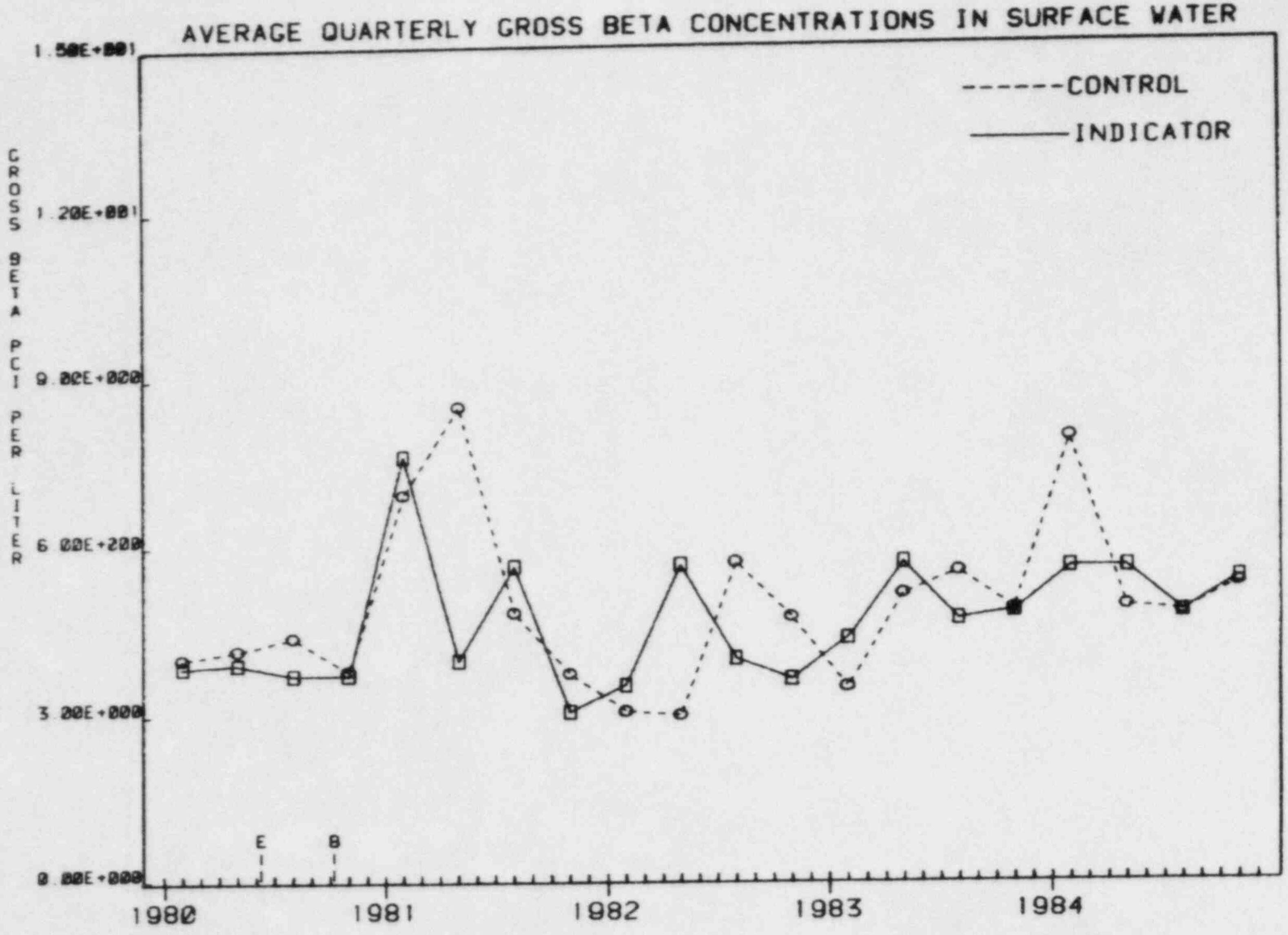


and drinking water are discussed below.

In general, there was little difference between indicator and control stations for both surface water and drinking water. In addition, the surface water results were similar to the drinking water results. Table 7 lists the range and the annual average gross beta concentration for each surface/drinking water station. The surface water station with the highest annual mean was station F15-1, Chickies Creek. This control station had an annual mean gross beta activity of 10.1 pCi/L, with monthly values ranging from 5.0 pCi/L to 34.0 pCi/L. The 34.0 pCi/L was the largest single value measured all year, and was an important contribution to the elevated mean for this station. The indicator with the highest mean, station J1-2, ranked third among all the surface water stations. Its mean and range were 7.6 pCi/L and 2.7 to 15.0 pCi/L, respectively. The control surface water stations grouped together had an annual average of 5.9 ± 5.2 pCi/L (± 1 sigma) while the indicator average was 5.3 ± 3.3 pCi/L. Figure 4 depicts the variation in the monthly averages at indicator and control stations. There was an 84 percent correlation between these two groups of surface water stations. Longer term variations of the gross beta activity of surface water may be seen in Figure 5.

In general, the annual mean gross beta activity was lower in drinking water than in surface water samples. (See

FIGURE 5



(B) CHINESE NUCLEAR DETONATION (E) TMI-2 REACTOR PURGE

FIGURE 4

MONTHLY GROSS BETA CONCENTRATIONS IN SURFACE WATER

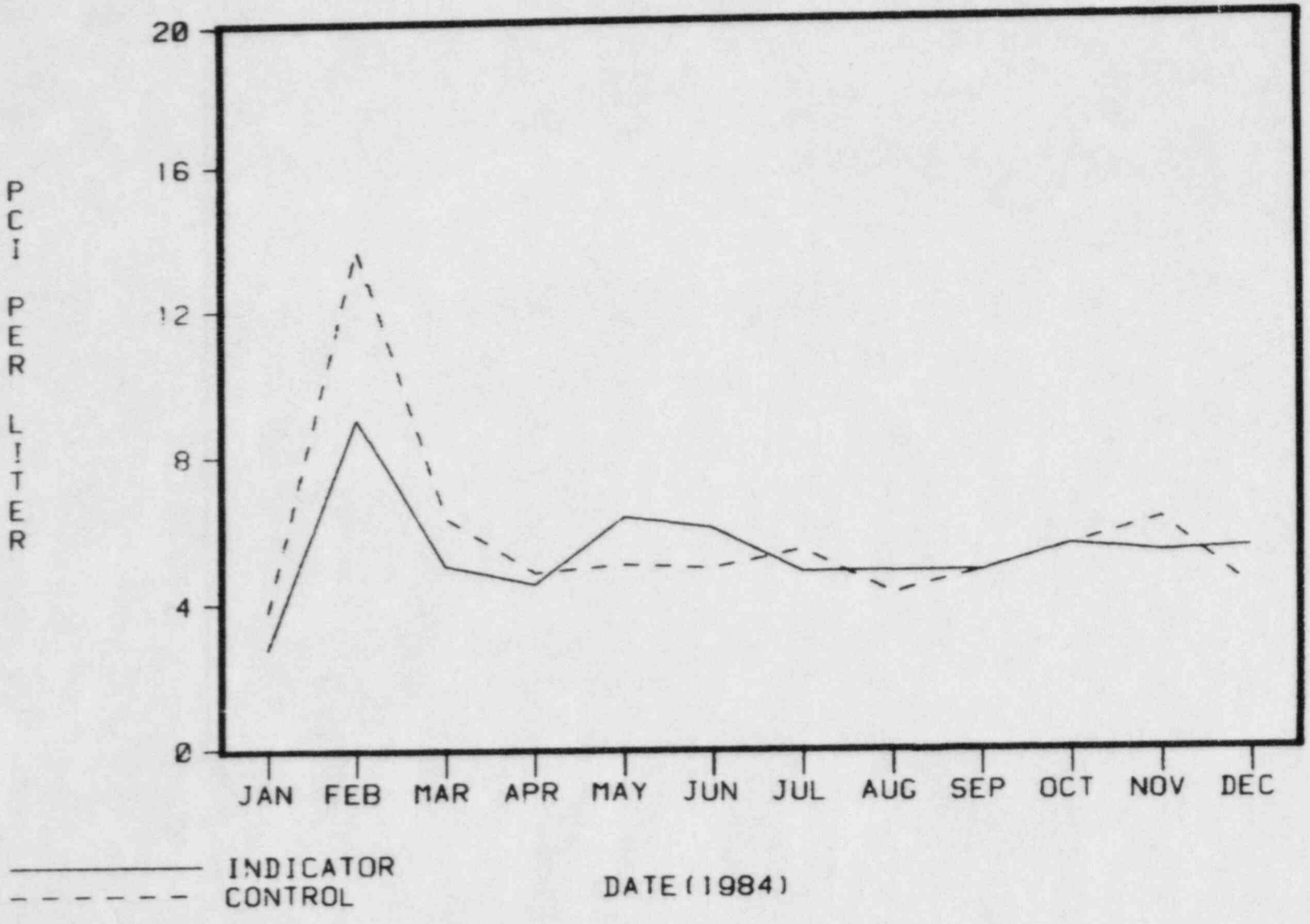


FIGURE 5

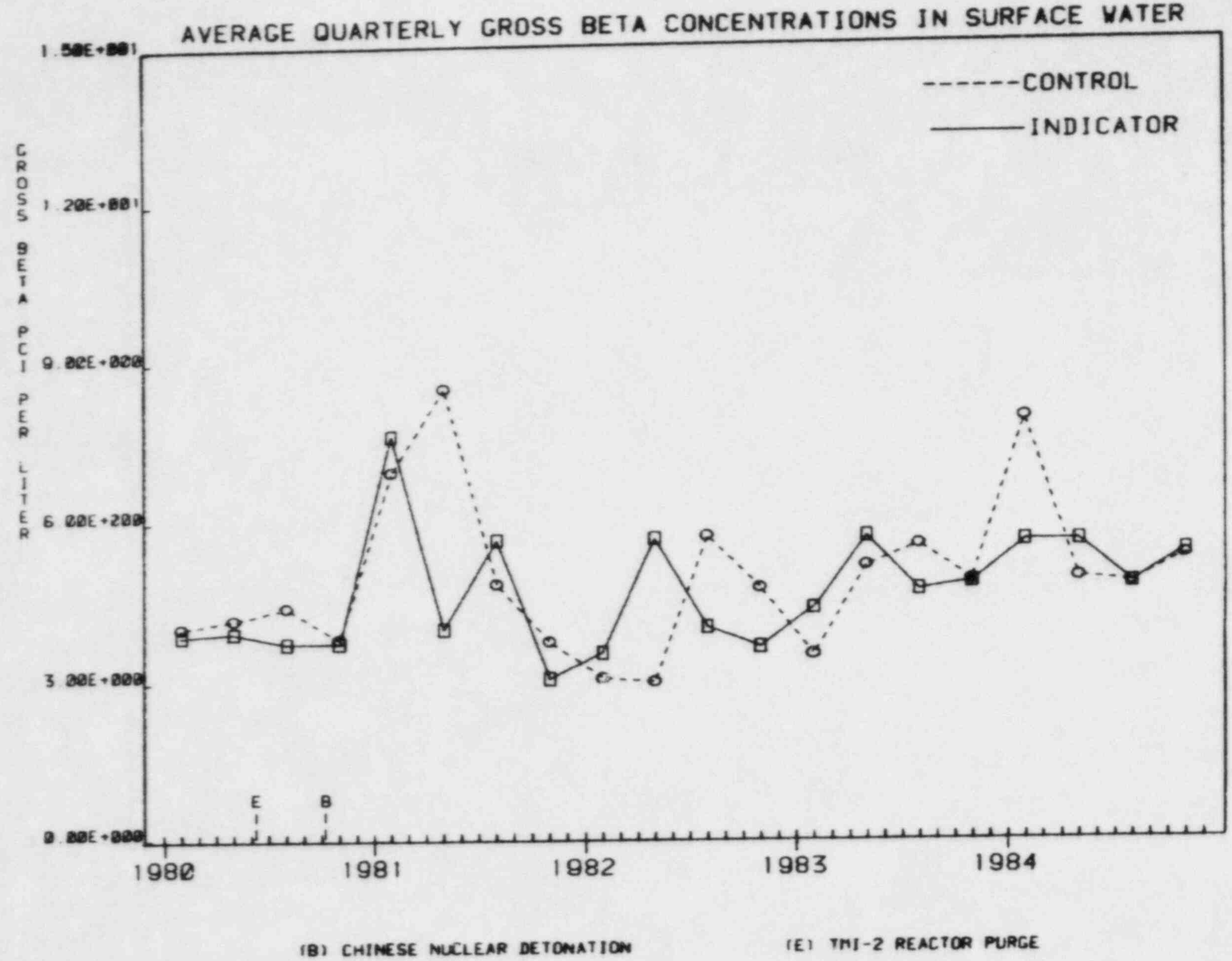

AVERAGE QUARTERLY GROSS BETA CONCENTRATIONS IN SURFACE WATER
------CONTROL
———INDICATOR
GROSS BETA PCI PER LITER
1.50E+001
1.20E+001
9.00E+000
6.00E+000
3.00E+000
0.00E+000
1980
1981
1982
1983
1984
E
B
(B) CHINESE NUCLEAR DETONATION
(E) TMI-2 REACTOR PURGE

Table 7.) This is not surprising in light of the fact that sediment is filtered from the water as part of the treatment process. It is known that sediment contains naturally occurring and fallout radionuclides which will contribute to the gross beta activity. As a group, the indicator drinking water stations had an annual mean gross beta concentration of 2.9 $\pm$ 1.0 pCi/L ($\pm$ 1 sigma) and the background stations had a value of 2.9 $\pm$ 1.1 pCi/L. The monthly means for indicators and controls are plotted in Figure 6. The individual station with the highest mean was indicator station G15-2, the Wrightsville Water Treatment Plant. Its value was 3.6 pCi/L. The next highest mean occurred at control station J15-2, where the value was 3.2 pCi/L.

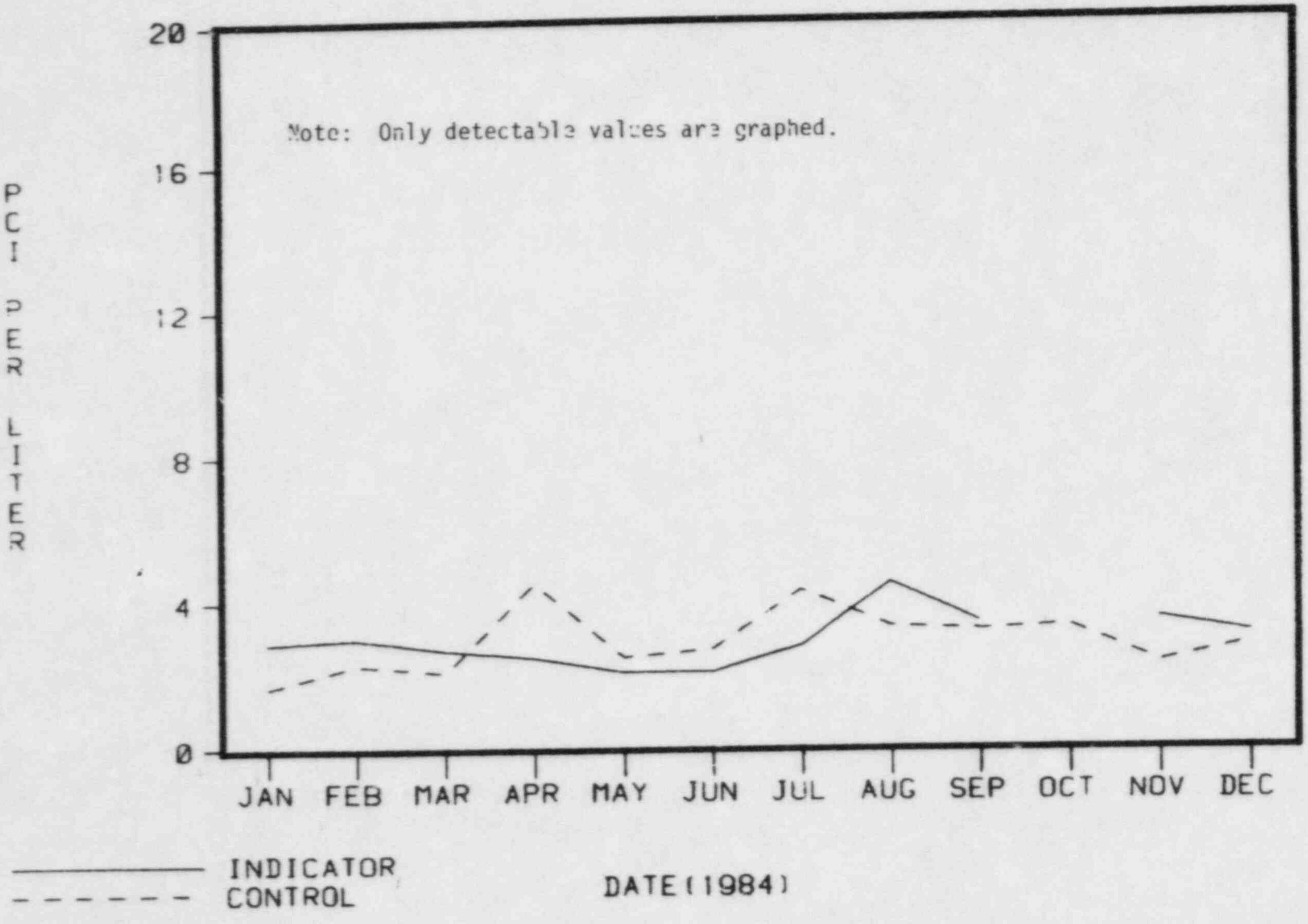
Statistical analysis of the drinking water gross beta data revealed that while the annual means were similar, the variation of the monthly indicator and background means were not well correlated. There were also statistically significant differences between some of the individual stations. No consistent upward trend is indicated by the gross beta data for either surface water or drinking water.

Strontium-89 and 90

Sixty-one (61) quarterly composites were prepared from surface and drinking water and were analyzed for the presence of Sr-89 and Sr-90. None of these primary samples contained detectable levels of either isotope. There were

FIGURE 6

MONTHLY GROSS BETA CONCENTRATIONS IN DRINKING WATER



two instances during 1984 in which Sr-90 was reported by the quality control laboratory for split samples. The validity of the values was in question because of the laboratories technical difficulties with this analysis.

Gamma Emitting Radionuclides

Excluding the duplicate and quality control samples, one hundred eighty-three (183) monthly composite samples of surface and drinking water were analyzed for the presence of gamma emitting radionuclides. Using high resolution Ge(Li) detectors, the composites were analyzed for the eleven Technical Specification required reactor produced radionuclides listed in Table 3. Any other gamma emitting radionuclides that were detected were also reported.

None of the surface or drinking water composites were found to contain detectable levels of reactor produced radionuclides. The only gamma-emitting radionuclide detected all year was K-40. This is a naturally occurring isotope commonly found in environmental samples.

4.1.2 Effluent Water

Effluent water was collected by an automatic water compositor in the TMINS discharge canal. The collection occurred after liquid plant effluents had been diluted by mechanical draft cooling tower flow, but prior to discharge into the Susquehanna River. Because of the potential for radionuclides in this water, it was subjected to thorough analysis. Samples were routinely obtained on a biweekly schedule except for those listed in Table 2. Additionally, a weekly sample was collected to closeout a quarterly composite period. They were subjected to the same analyses as surface and drinking water samples. The weekly and biweekly discharge samples were analyzed for I-131 and monthly composites were analyzed for gross beta activity, H-3, and gamma emitting radionuclides. Quarterly composites were analyzed for Sr-89 and Sr-90. Additional analyses performed on discharge water included monthly analyses for phosphorous-32 (P-32), iron-55 (Fe-55), and gross alpha activity. For comparison, an identical analysis regime was followed for samples from the TMI-1 intake station N1-2A.

There was no P-32, Fe-55, Sr-89 or gross alpha activity found in any of the discharge water analyzed during 1984. For the third quarter composite, the quality control laboratory reported a Sr-90 concentration of 0.30 $\pm$ 0.28 pCi/L, but the main laboratory reported a value of "less than" 0.9 pCi/L for the corresponding sample. Although small concentrations of Sr-90 were released by both TMI-1 and TMI-2 during the third quarter of 1984, its presence in detectable quantities at the discharge is questionable based on dilution factors. As stated previously, the quality control laboratory has had difficulty with this analysis. No reactor-produced radionuclides were detected in the monthly gamma scans of effluent water. The only gamma emitter detected during 1984 was naturally occurring K-40.

Iodine-131 was found sporadically in the TMINS discharge water. The incidents of occurrence are listed in Table 5 along with the positive results for surface and drinking water. No consistent pattern of appearance is evident from the table entries. Since I-131 has not been produced on Three Mile Island since 1979, its occurrence in the effluent water must be related to sources other than TMINS. The sample with the highest I-131 concentration contained only 0.56 ± 0.19 pCi/L. This value is approximately one fourth of the NRC reporting level. As mentioned previously, I-131 was not detected in any of the drinking water samples collected during 1984.

Only monthly gross beta and H-3 analyses consistently yielded positive results. The monthly gross beta results are listed in Table 8 and graphed in Figure 7. The annual mean gross beta concentration at station K1-1 was 4.8 pCi/L with a range from 3.4 to 7.2 pCi/L. For comparison, the annual mean at control surface water stations was 5.9 pCi/L, while the indicator mean was 5.3 pCi/L. The individual monthly values were generally comparable to surface water results, but statistical analysis revealed that there was poor correlation between individual surface/drinking water stations and the station discharge. The monthly mean from

TABLE 8

1984 MONTHLY GROSS BETA AND TRITIUM CONCENTRATIONS

IN EFFLUENT WATER*

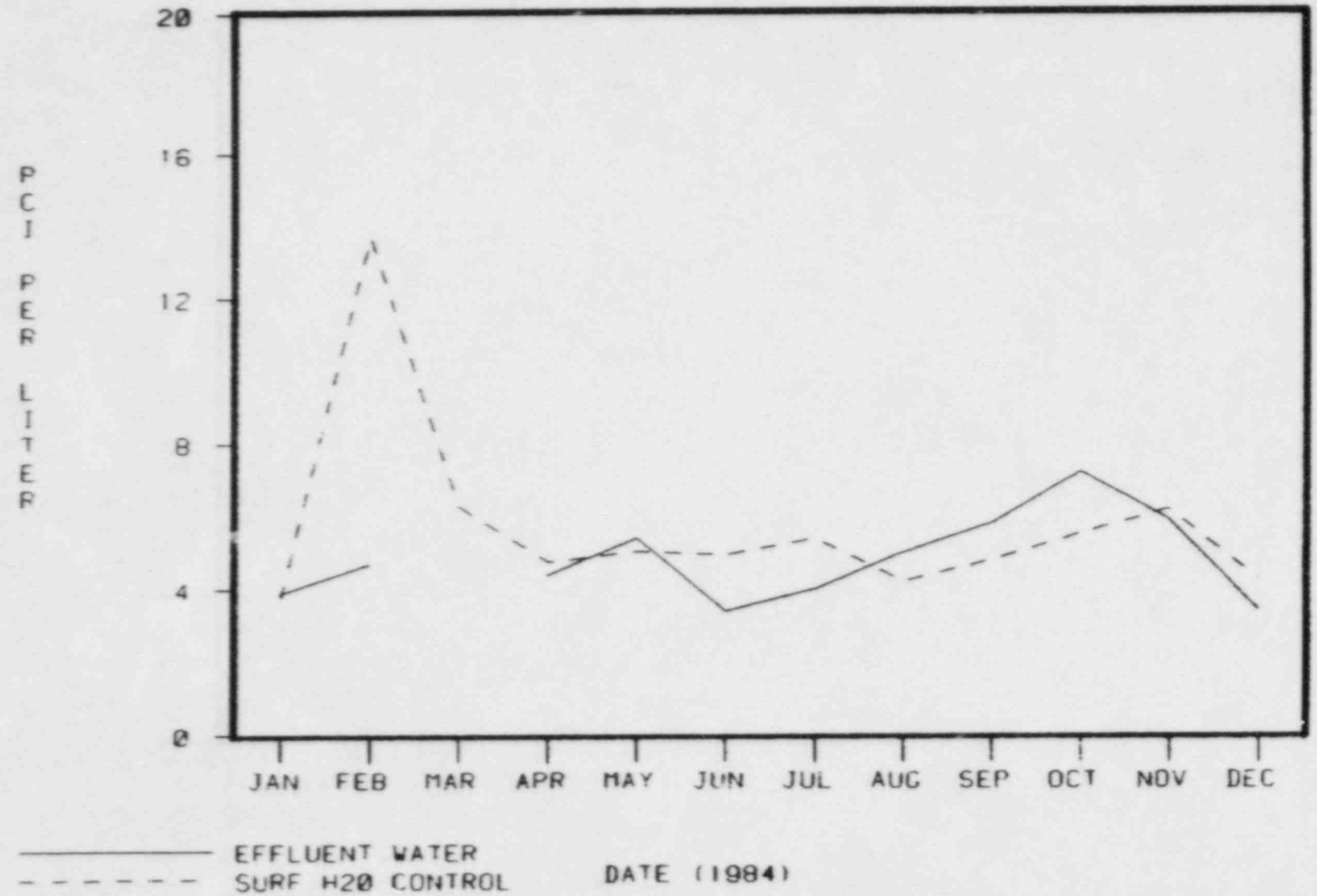
(pCi/L ± 2σ)

	Tritium	Gross Beta
January	170 ± 70	3.9 ± 1.1
February	100 ± 40	4.7 ± 1.1
March	90 ± 52	<1.0
April	70 ± 51	4.4 ± 1.1
May	<60	5.4 ± 1.0
June	340 ± 50	3.4 ± 1.1
July	170 ± 40	4.0 ± 1.0
August	89 ± 39	5.0 ± 1.1
September	140 ± 30	5.8 ± 1.3
October	160 ± 30	7.2 ± 1.3
November	130 ± 40	5.9 ± 1.2
December	100 ± 40	3.4 ± 0.9

* Samples obtained in the station discharge canal prior to discharge into the Susquehanna River.

FIGURE 7

MONTHLY GROSS BETA CONCENTRATIONS IN EFFLUENT WATER

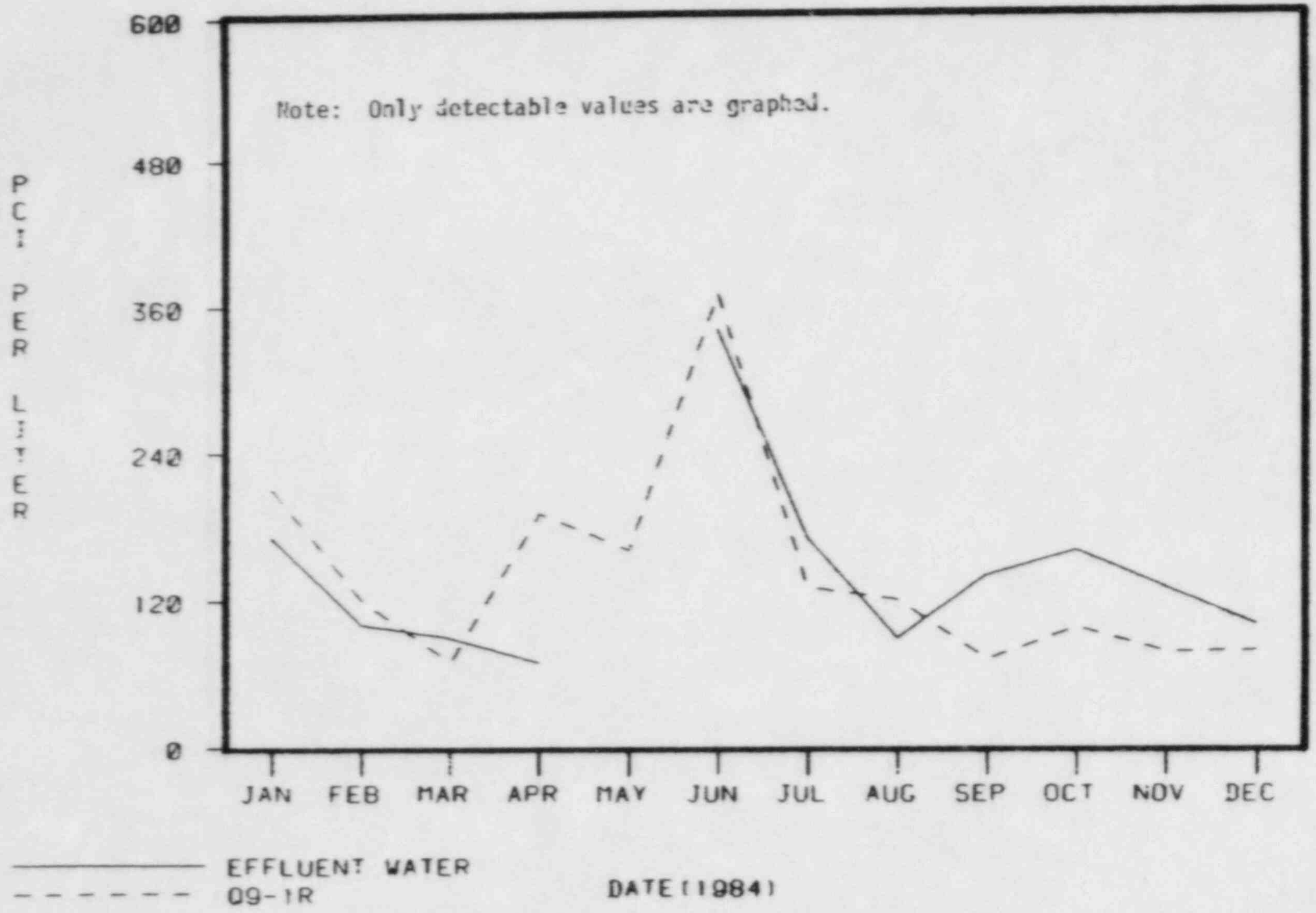


control surface water stations is plotted with the effluent concentration in Figure 7 for comparison. Although the annual means were similar, the fluctuations from month to month were not.

Generally, H-3 values at the station discharge (K1-1) were also similar to those for surface and drinking water. Station K1-1 had an annual mean of 142 pCi/L and a range of "less than" 60 to 340 pCi/L. The annual mean for control surface water stations was 120 pCi/L while control drinking water stations had a mean of 161 pCi/L. These above values lie within the normal range for environmental H-3 (100 pCi/L-350 pCi/L) and reflect the fact that TMINS had a negligible impact on the H-3 content of the aquatic environment. Statistical analysis revealed a high degree of correlation between the H-3 concentration at the TMINS discharge and upstream surface and drinking water stations. There was a 78 percent coefficient of correlation between the untreated water at station Q9-1R and the TMINS discharge. The correlation was even better, 92 percent, for the treated (drinking) water collected at Q9-1F, the Steelton Water Company. It is not surprising that the correlation was better for the treated water since the water discharged from TMINS at station K1-1 undergoes some pretreatment when it is withdrawn from the river. The variation in the H-3 concentration at the TMINS discharge are depicted in Figure 8.

FIGURE 8

MONTHLY TRITIUM CONCENTRATIONS IN EFFLUENT WATER



The variations at station Q9-1, nine miles upstream from TMI, are shown for comparison. There is nc evidence in this figure for a persistent upward trend in th. H-3 data.

4.1.3 Groundwater

Groundwater data collected from monitoring locations on TMI continued during 1984. Tritium was the only radionuclide consistently detected. Stations located near the TMI-2 Reactor Building and Borated Water Storage Tank (BWST) showed H-3 concentrations ranging from 840 pCi/L to 26,000 pCi/L. The remaining stations located in the vicinity of the TMI-2 secured-area fence showed H-3 concentrations ranging from 190 pCi/L to 1,300 pCi/L. Normal background concentrations range from 150 pCi/L to 300 pCi/L. Two control stations located away from the plant at the north and south ends of Three Mile Island showed background concentrations of H-3. Tritium concentrations in the East Dike Catch Basin (EDCB), a stormwater collection basin, ranged from 80 pCi/L to 260 pCi/L. All H-3 concentrations in groundwater samples were below the limits established in Title 10 of the Code of Federal Regulations, Part 20, Appendix B, for water in unrestricted areas (3,000,000 pCi/L). Results of the sampling and analysis program for the present investigational period are presented in Appendix J.

Based on hydrogeologic data for the TMI site, groundwater stored within TMI poses no contamination threat to domestic wells. As a result, no adverse effects on the groundwater quality outside of TMI was evidenced. The natural hydrologic cycle, combined with long groundwater transport times, will prevent any groundwater contamination from TMI adversely affecting the Susquehanna River.

4.1.4 Fish

Fish samples were collected in July-August and again in September-November of 1984. The edible portions were analyzed for Sr-89 and Sr-90 and reactor produced gamma emitting radionuclides (See Table 3). To monitor progression of radionuclides through the food chain, bottom feeding fish as well as predators were sampled. Indicator samples were collected downstream of the TMINS discharge, while control specimens were gathered from locations greater than 10 miles upstream.

Strontium-89 was not detected in any of the fish samples collected during 1984 with the exception of one quality control sample. The marginally positive result was 0.008 ± 0.008 pCi/gm(wet). This result was considered to be invalid, since Sr-89 has not been produced at TMINS for over five years and very little if any remains due to its relatively short half-life (51 days). Also, the laboratory performing the analysis has had difficulty with this analysis as well as the Sr-90 analysis. Strontium-90 was identified in both indicator and control predators, but not in bottom feeders. The Sr-90 values for indicator predator samples ranged from 0.017 to 0.022 pCi/gm (wet), with a mean of 0.020 pCi/gm (wet). Control predator values covered a range from 0.010 to 0.014 pCi/gm (wet), with a mean of 0.012 pCi/gm (wet). The Sr-90 values for both indicators and controls were not considered significantly different. The values in both classes are consistent with preoperational data and are attributed to residual fallout from weapons testing.

The only fission product identified by gamma spectroscopy was Cs-137. It was found in both indicator and control specimens at extremely low concentrations. The levels found were consistent with past years data and are attributed to fallout. Grouping indicators and controls together, the concentration of Cs-137 in predator fish ranged from <0.006 to 0.008 pCi/gm (wet) while the bottom feeder results varied between <0.010 and 0.071 pCi/gm (wet). The mean of the positive values was 0.008 pCi/gm (wet) for predators (one positive result) and 0.033 pCi/gm (wet) for bottom feeders. Gamma spectroscopy also identified the presence of naturally occurring K-40 in the fish samples collected in 1984.

4.1.5 Crayfish

Several environmental factors may influence the bioaccumulation rate of radionuclides in fish flesh. Three potential factors--water, aquatic plants, and sediment--are currently investigated. A fourth potential factor, radionuclide concentrations in the forage base of fishes, was the subject of a special study during 1984. A crayfish caging study was performed to further investigate the assimilation of radionuclides in the aquatic biota and to assess potential impacts from TMINS liquid effluents.

Crayfish used in the TMINS study were purchased from a hatchery in Elverton, Pennsylvania. Gamma isotopic analysis was performed on a sample (control) prior to field placement to determine baseline activity in the crayfish. Two hundred crayfish were then placed upstream (background) and downstream (indicator) of the TMINS discharge on May 4, 1984. Crayfish and sediment samples were retrieved from each location monthly, from June through September, and counted on a high resolution Ge(Li) detector. Enough crayfish survived at the indicator station to provide October and November samples. The Maryland Power Plant Siting Program provided the original study design and performed parallel studies at the Peach Bottom Atomic Power Station (personal communication, Mr. Richard I. McLean).

Sediment samples contained positive Cs-137 and naturally occurring K-40, radium-226 (Ra-226) and actinium-228 (Ac-228). Cesium 137 levels ranged from 0.041 ± 0.010 to 0.21 ± 0.02 pCi/g (wet) and occurred at both indicator and background stations throughout the study. Naturally occurring K-40, Ra-226 and Ac-228 existed in all background and indicator crayfish samples. The control crayfish sample, counted prior to field placement, and the November indicator sample also contained positive Cs-137 (0.038 ± 0.017 and 0.044 ± 0.033 pCi/g-wet, respectively).

Without a background crayfish sample available for comparison, it is difficult to interpret the positive Cs-137 value in the November indicator sample. However, the value was consistent with the initial control sample and was barely above LLD. The Cs-137 values detected in the sediment samples were consistent with levels found during the routine REMP sediment sampling and, since evident at both background and indicator stations, are probably due to fallout from weapons testing.

4.1.6 <u>Vegetation</u>

Aquatic plants were collected twice during 1984. No indicator sample was available for the October collection. They were analyzed for Sr-89 and Sr-90 and gamma emitting radionuclides. No Sr-89 was detected except in the quality control samples. For the reasons discussed in Section 4.1.4, these values were not considered valid. Low levels of Sr-90 and Cs-137 were found. The data for both radionuclides were consistent with the findings from previous years and are attributable to atmospheric fallout. Naturally occurring Be-7, K-40 and Th-228 were also identified. The averages and ranges are reported in Table 3.

4.1.7 Sediment

In July and October of 1984, aquatic sediment samples were taken from the Susquehanna River upstream and downstream of TMINS. They were analyzed for Sr-89, Sr-90, and gamma emitting radionuclides. Strontium-89 was detected in the July quality control sediment sample. However, no Sr-89 was detected in the reanalysis. Only the quality control samples collected in July and October were found to contain marginally positive Sr-90. The values reported for the station located approximately 1.5 miles below the TMINS discharge (J2-1Q) were 0.014 $\pm$ 0.008 and 0.012 $\pm$ 0.008 pCi/gm (dry) for the samples collected in July and October, respectively. The corresponding results for the base program station were <0.03 and <0.008 pCi/gm (dry). Both positive results are well below the preoperational mean of 0.39 pCi/gm (dry). Strontium-90 is a nuclear weapons fallout product commonly found in environmental samples.

Gamma isotopic analysis revealed the presence of naturally occurring Be-7, K-40, Ra-226 and Th-228. Additionally, Cs-137 was found in all the sediment samples collected. However, due to its long half-life, Cs-137 resulting from weapons fallout is commonly found in environmental samples. The Cs-137 values ranged from 0.14 to 0.24 pCi/gm (dry) at the control station, while the indicator station concentrations varied from 0.20 to 0.52 pCi/gm (dry). The mean concentration for the control station was 0.19 pCi/gm (dry) and the corresponding value for the indicator stations was 0.38 pCi/gm (dry). These two values are similar to the preoperational Cs-137 concentration of 0.43 ± 0.29 pCi/gm (dry). Past weapons tests contributed to the presence of this radionuclide.

4.2 Atmospheric Environment

Monitoring of the atmospheric environment around Three Mile Island was conducted through collection and analysis of air particulate filters, charcoal cartridges and precipitation samples. Air particulate and air iodine samples were collected at eight locations with low volume air samplers. Air particulate samples were collected on filters in tandem with charcoal cartridges for collecting air iodine samples. Air volumes were measured and recorded with dry gas meters. Both air particulate and iodine samples were collected weekly.

Precipitation was collected utilizing 13-inch diameter funnels that drain into 5-gallon polyethylene bottles. Samples were collected monthly.

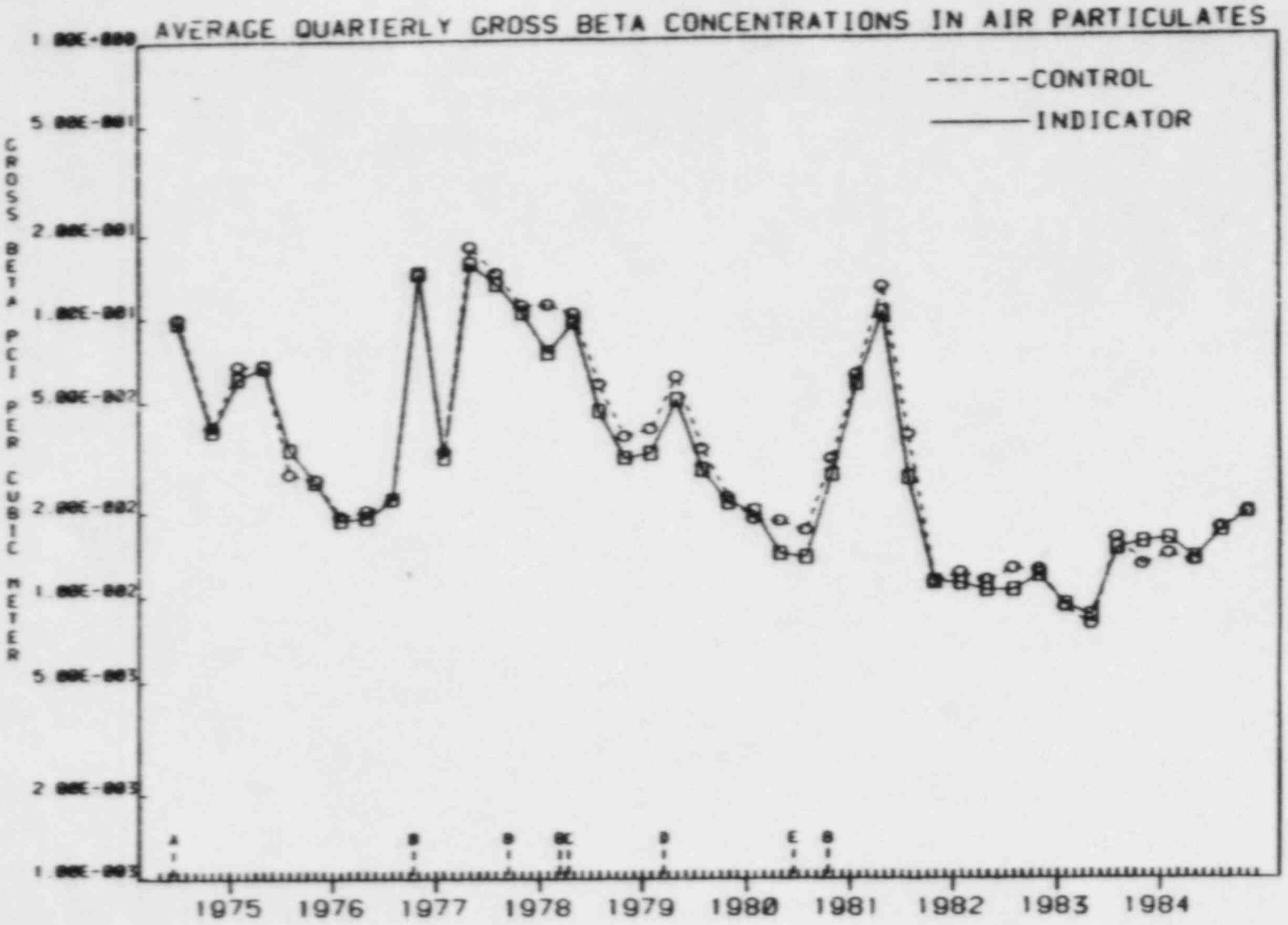
4.2.1 Air Particulates

Air particulate samples were analyzed weekly for gross beta concentrations then composited by individual stations for monthly gamma isotopic analysis. Quarterly composites of individual stations were analyzed for gross alpha activity and Sr-89 and Sr-90. Additionally, during a seven-week period (June 20 - August 8), gross alpha analyses were performed weekly to monitor the TMI-2 head lift operations. Whereas, the gamma isotopic, Sr-89, and Sr-90 analyses are nuclide specific, the gross activity analyses (beta and alpha) only provide a measure of overall activity without identifying the specific nuclides present. Although no meaningful conclusions can be deduced from the results with respect to their dosimetric significance, these gross measurements are useful as trend indicators.

Results of the gross beta analyses provided comparisons between indicator and control stations for the year, as well as comparisons between locations in relation to spatial and temporal differences. The calculated annual means for both indicator and control stations were 0.016 pCi/M^3. These values are consistent w[illegible]e 1983 averages of 0.013 and 0.012 pCi/M^3 for indic[illegible]or and control stations, respectively. The stations with the highest annual average were the indicator stations located at the TMINS North Weather Station (A1-1) and Falmouth (H3-1), both with a mean of 0.017 pCi/M^3, which is well below the preoperational mean of 0.150 pCi/M^3. The general trends noted in previous years are presented in Figure 9.

Statistical analysis of the detectable gross beta con-

FIGURE 9



(A) TMI-1 INITIAL CRITICALITY
(B) CHINESE NUCLEAR DETONATION
(C) TMI-2 INITIAL CRITICALITY
(D) TMI-2 ACCIDENT
(E) TMI-2 REACTOR PURGE

centrations obtained during the 1984 reporting period indicated that there was no significant difference between indicator and control stations at the 95 percent confidence level ($P \leq 0.05$). Evidence for this fact may be seen from the similarity of the trends in the average monthly gross beta concentrations displayed in Figure 10. Additionally, no significant difference was indicated between individual stations. Individual station averages for the year are presented in Table 9.

Fluctuations in the gross beta concentrations were noted throughout the year. Monthly average gross beta concentrations for indicator and control stations are presented in Table 10 and are depicted in Figure 10.

The general trend for average monthly gross beta concentrations in the indicator stations showed good correlation ($r = 0.86$) with control stations throughout the monitoring period. A diminution in activity in both indicator and control locations was noted from the beginning of the monitoring period until April after which a gradual rise in activity occurred and continued throughout the remaining months of the year. These fluctuations were unrelated to TMINS since both indicator and control stations were affected. All gross beta concentrations for 1984 are within natural background levels and no increases were noted during the period of the TMI-2 head lift operations.

FIGURE 10

MONTHLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATES

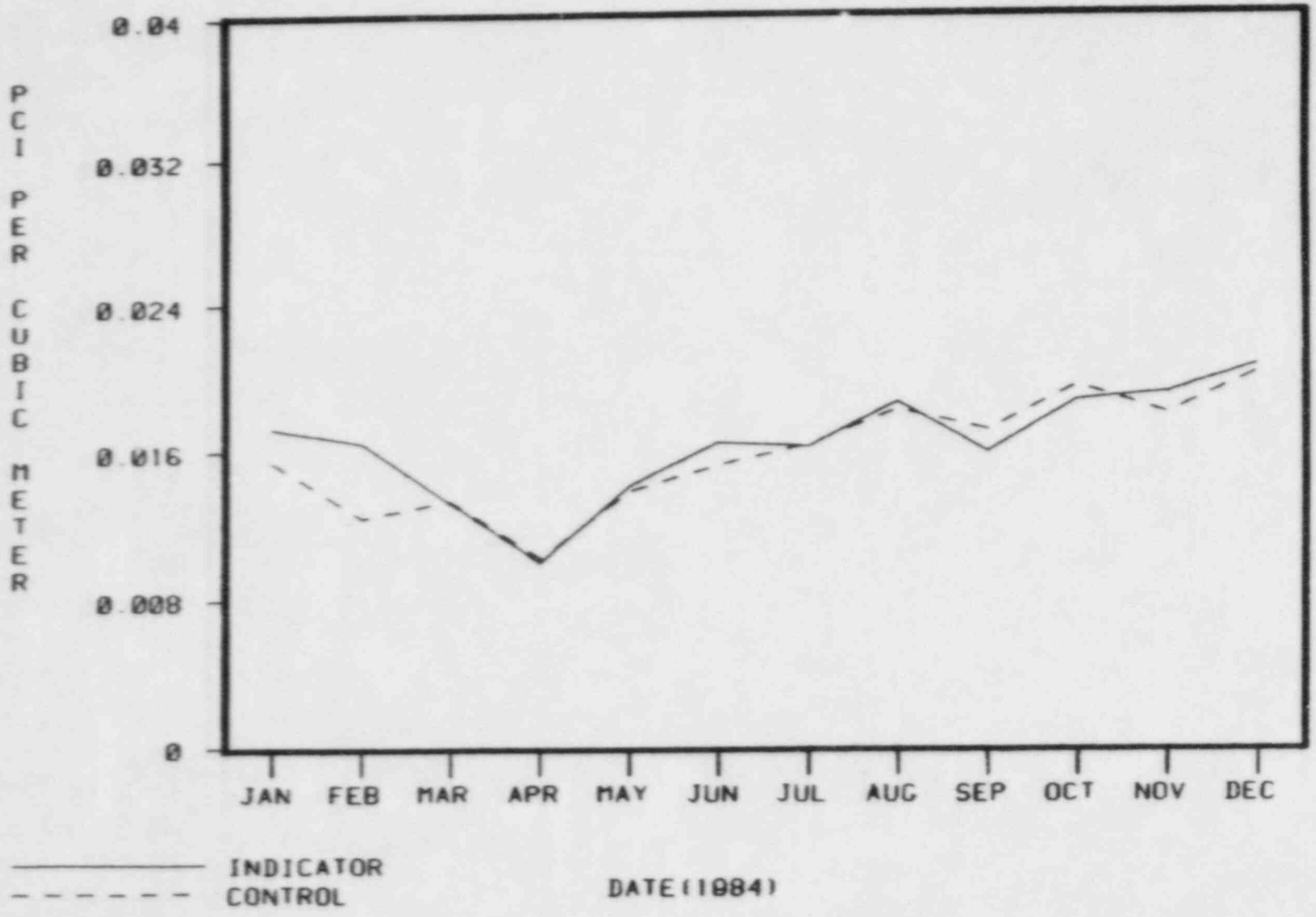


TABLE 9

1984 AVERAGE GROSS BETA CONCENTRATIONS

IN AIR PARTICULATES

(pCi/M^3)

Station	Description	Average*
A1-1(I)	TMINS North Weather Station	0.017
H3-1(I)	Falmouth	0.017
E1-2(I)	TMINS Observation Center	0.016
M2-1(I)	Goldsboro	0.015
A3-1(I)	Middletown	0.016
Q15-1(C)	West Fairview	0.015
G10-1(C)	Drager Farm (Marietta)	0.016
J15-1(C)	York	0.016

(I) = Indicator Station
(C) = Control Station

*Based on detectable values only

TABLE 10

1984 MONTHLY AVERAGE GROSS BETA CONCENTRATIONS IN INDICATOR AND CONTROL AIR PARTICULATE STATIONS

(pCi/M^3)

Date	Indicator*	Control*
January	0.017	0.015
February	0.016	0.012
March	0.013	0.013
April	0.010	0.010
May	0.014	0.014
June	0.016	0.015
July	0.016	0.016
August	0.019	0.018
September	0.016	0.017
October	0.019	0.020
November	0.019	0.018
December	0.021	0.020

*Based on detectable values only

Analysis of particulate filters for gamma emitting radionuclides yielded only naturally occurring isotopes (Be-7 and K-40) and low-level Cs-137. Cesium-137 was detected sporadically at both indicator and control stations throughout the monitoring period, occurring primarily in the first and fourth quarters. The five detectable results at indicator stations ranged from 0.0012 pCi/M^3 to 0.0129 pCi/M^3 with an annual average of 0.0064 pCi/M^3. Control stations ranged from 0.0017 pCi/M^3 to 0.0063 pCi/M^3 with an annual average of 0.0035 pCi/M^3, based on seven detectable results. The occurrence of Cs-137 was related to atmospheric fallout from prior weapons testing and not a result of TMINS operations since both indicators and control stations had detectable values. No Cs-137 was detected during the period of the TMI-2 head lift operation.

Quarterly strontium analysis was performed on a total of 40 composite samples (including quality control samples) during 1984. No Sr-89 was detected. In the first quarterly period of 1984, low-level Sr-90 was detected at one indicator and two control stations. Indicator station A1-1 had a concentration of 0.00033 pCi/M^3, while control stations G10-1 and J15-1 had detectable Sr-90 concentrations of 0.00025 and 0.00030 pCi/M^3, respectively. All three concentrations are consistent with background levels for residual fallout from prior atmospheric nuclear weapons tests. Strontium-90 was not detected in air during the remaining three quarters of 1984.

Trends noted for gross alpha concentrations during 1984 are presented in Table 11 and depicted in Figure 11. Generally, both indicators and controls fluctuated similarly (r = 0.80). The annual average gross alpha concentration for indicator stations was 0.0025 pCi/M^3 while control stations averaged 0.0023 pCi/M^3. Both values are similar to 1983 averages of 0.0020 pCi/M^3 and 0.0022 pCi/M^3 for indicator and control stations, respectively. The indicator station located at the TMINS North Weather Station (A1-1) had the highest annual average of 0.0030 pCi/M^3 with a range of 0.0016 pCi/M^3 to 0.0038 pCi/M^3.

Statistical analysis of the data revealed no significant difference between indicator and control stations at the 95 percent confidence level ($P \leq 0.05$) as well as no significant difference between individual stations.

To effectively monitor the TMI-2 head lift operations, the REMP was augmented to include weekly analysis of particulate filters for gross alpha activity. For the period of June 20 to August 8 indicator stations averaged 0.0011 pCi/M^3 with a range of 0.0007 pCi/M^3 to 0.0014 pCi/M^3. Control stations were similar averaging, 0.0011 pCi/M^3 and ranging from 0.0007 pCi/M^3 to 0.0020 pCi/M^3.

TABLE 11

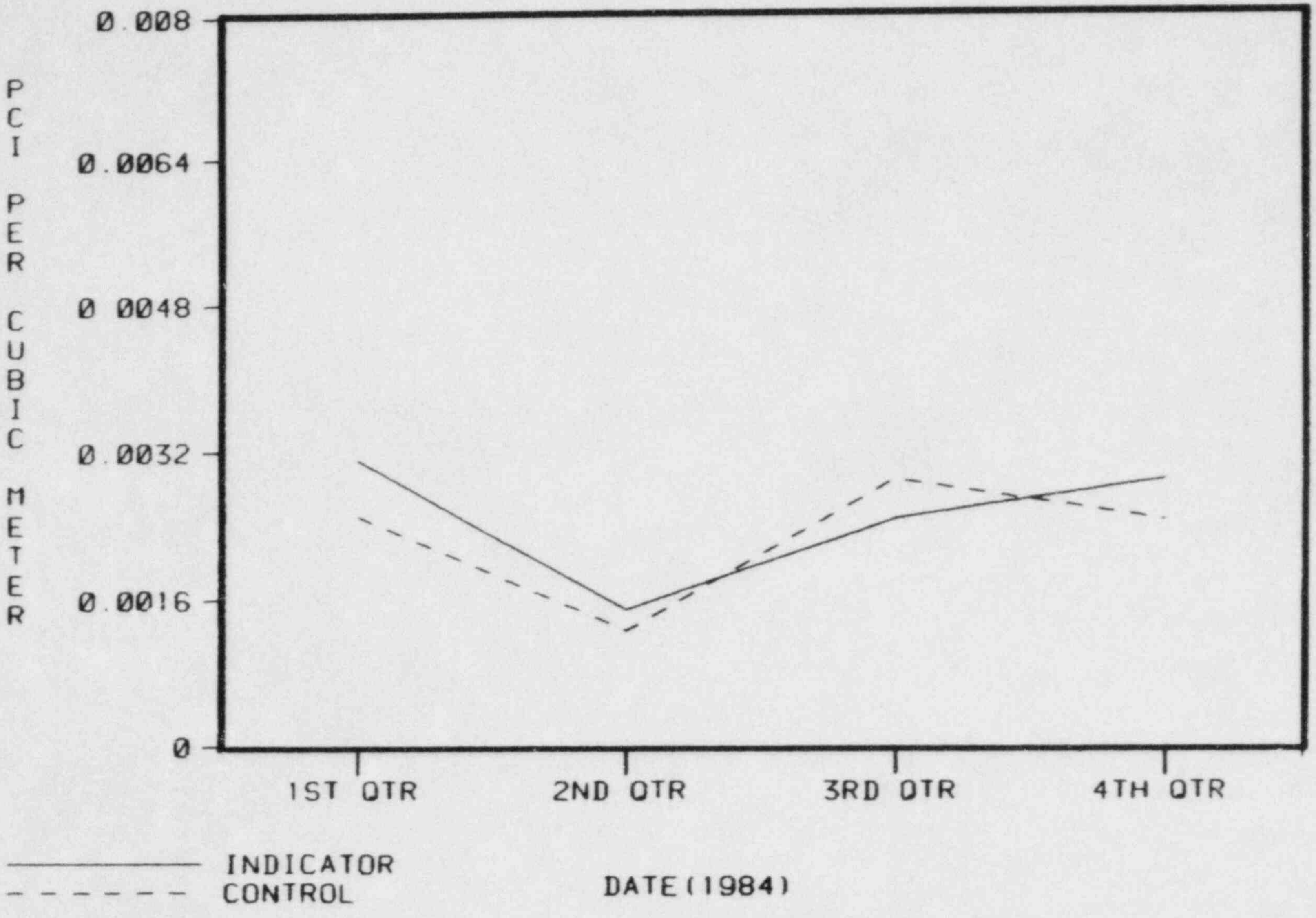
1984 QUARTERLY AVERAGE GROSS ALPHA CONCENTRATIONS IN AIR PARTICULATES

(pCi/M^3)

Quarter	Indicator	Control
1st	0.0031	0.0025
2nd	0.0015	0.0013
3rd	0.0025	0.0029
4th	0.0029	0.0025

FIGURE 11

QUARTERLY GROSS ALPHA CONCENTRATIONS IN AIR PARTICULATES



All concentrations within this special sampling period as well as those throughout the entire monitoring period were found to be consistent with background levels for gross alpha activity. Figure 12 depicts trends in gross alpha concentrations since 1980.

4.2.2 Air Iodine

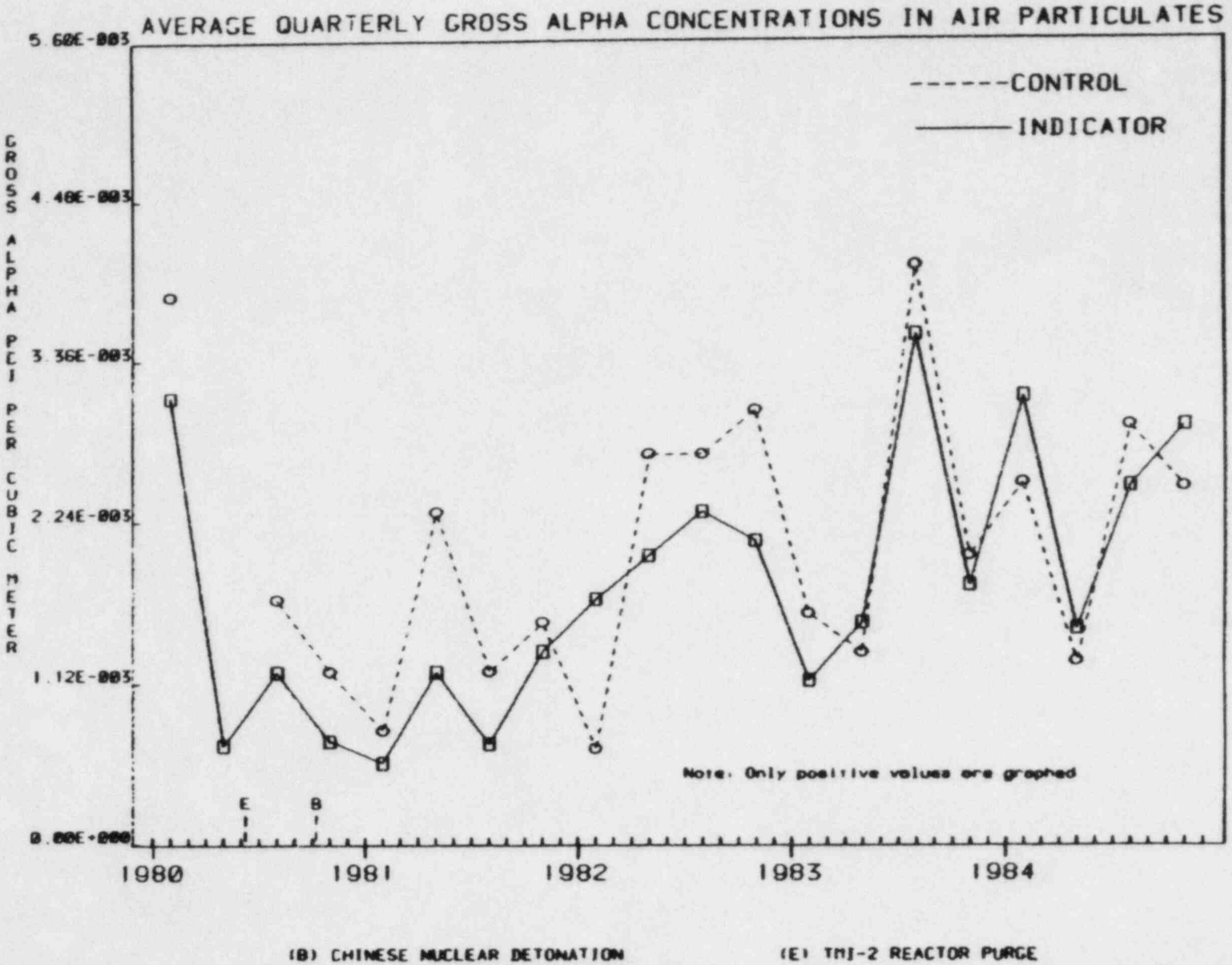
Analyses of weekly charcoal cartridges for I-131 revealed no detectable concentrations from any of the eight air monitoring stations. All analyses results were less than the analytical lower limit of detection (LLD) of 0.07 pCi/M^3 (with the exception of the sample listed in Appendix B). Consequently, there were no environmental impacts associated with this radionuclide.

4.2.3 Precipitation

Monthly precipitation samples from five locations were analyzed for gross beta activity, H-3, Sr-89 and Sr-90, and gamma emitting radionuclides.

Table 12 and Figure 13 depict the monthly gross beta averages for indicator and control stations for 1984. Indicator stations averaged 2.9 pCi/L with a range of 0.9 to 8.4 pCi/L while control stations averaged 2.6 pCi/L with a range of 0.7 to 5.9 pCi/L. The indicator station located at the TMINS Observation Center (E1-2) had the highest annual mean of 4.2 pCi/L which is well below the preoperational mean of 22.0 pCi/L. This station was relocated in the

FIGURE 12



AVERAGE QUARTERLY GROSS ALPHA CONCENTRATIONS IN AIR PARTICULATES
------CONTROL
INDICATOR
GROSS ALPHA PCI PER CUBIC METER
5.60E-003
4.48E-003
3.36E-003
2.24E-003
1.12E-003
0.00E+000
1980
1981
1982
1983
1984
E
B
Note: Only positive values are graphed
(B) CHINESE NUCLEAR DETONATION
(E) TMI-2 REACTOR PURGE

TABLE 12

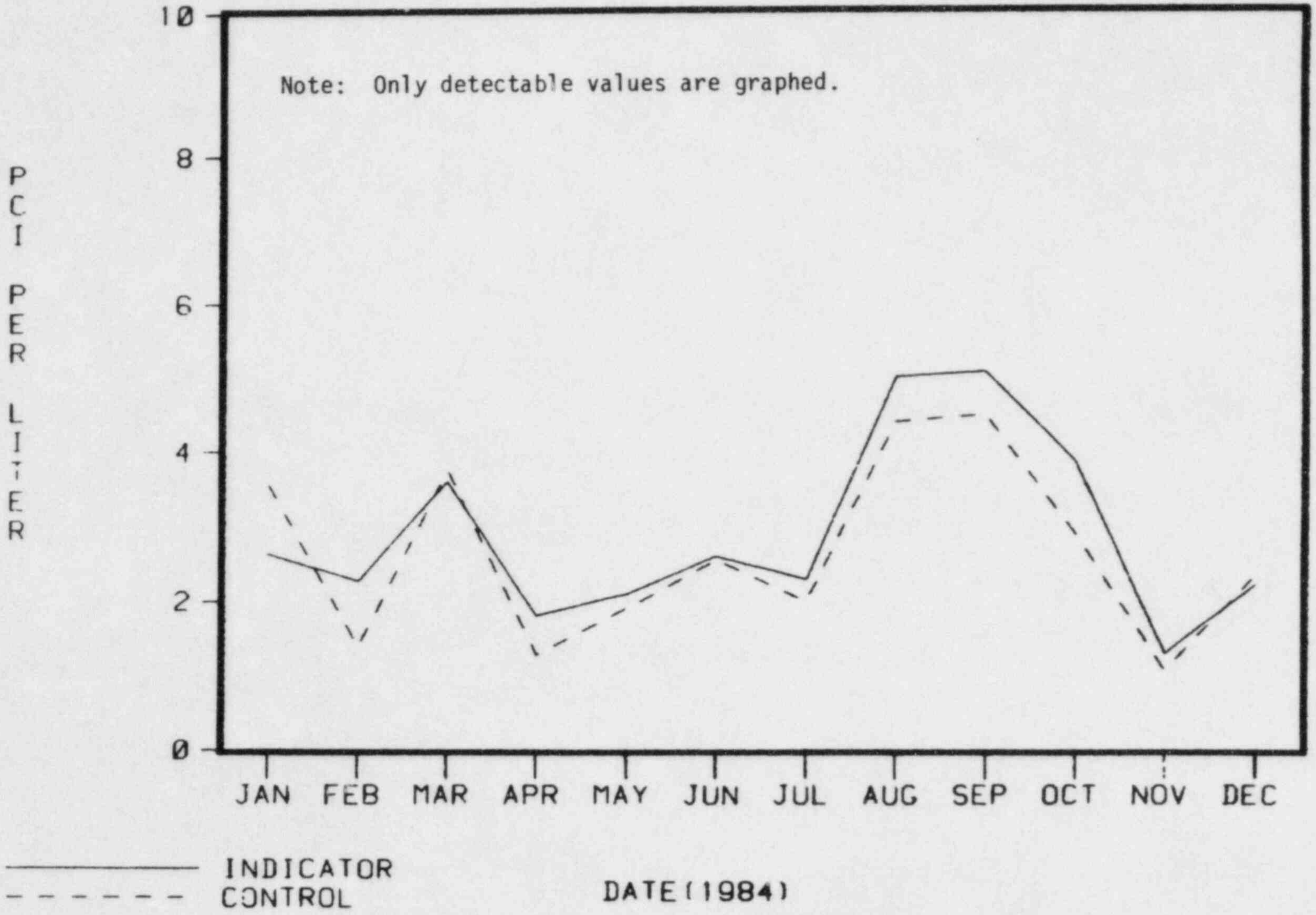
1984 MONTHLY GROSS BETA CONCENTRATIONS IN INDICATOR AND CONTROL PRECIPITATION STATIONS

(pCi/L)

Date	Indicator	Control
January	2.6	3.6
February	2.3	1.4
March	3.6	3.8
April	1.8	1.3
May	2.1	1.9
June	2.6	2.4
July	2.3	2.0
August	5.0	4.4
September	5.1	4.5
October	3.9	2.9
November	1.3	1.1
December	2.2	2.4

FIGURE 13

MONTHLY GROSS BETA CONCENTRATIONS IN PRECIPITATION



latter part of 1984 to an area which resulted in the collection of less organic debris (leaves) which tends to increase gross beta activity. Consequently, a decrease in gross activity was evidenced.

Statistical analyses of the detectable gross beta concentrations obtained during 1984 indicated that there was no statistically significant difference between indicator and control stations at the 95 percent confidence level ($P < 0.05$). Although interstation comparisons indicated that differences between locations did exist, each indicator station was similar to at least one control station. Individual station averages for the year are presented in Table 13. The similarity of trends ($r = 0.91$) can be seen from Figure 13. Increases were noted in both indicator and control stations for March, August, and September. These occurrences were related to natural phenomena and not associated with TMINS discharges since both indicator and control stations were affected. Figure 14 depicts gross beta concentrations in precipitation since 1980.

Analyses of quarterly composites for H-3 were performed on 20 samples during 1984. Indicator station values ranged from 97 to 240 pCi/L while control stations ranged from 70 to 100 pCi/L. The annual averages for indicator and control stations of 143 and 88 pCi/L, respectively, were less than the preoperational mean of 370 pCi/L. Indicator station

TABLE 13

1984 AVERAGE GROSS BETA CONCENTRATIONS IN PRECIPITATION

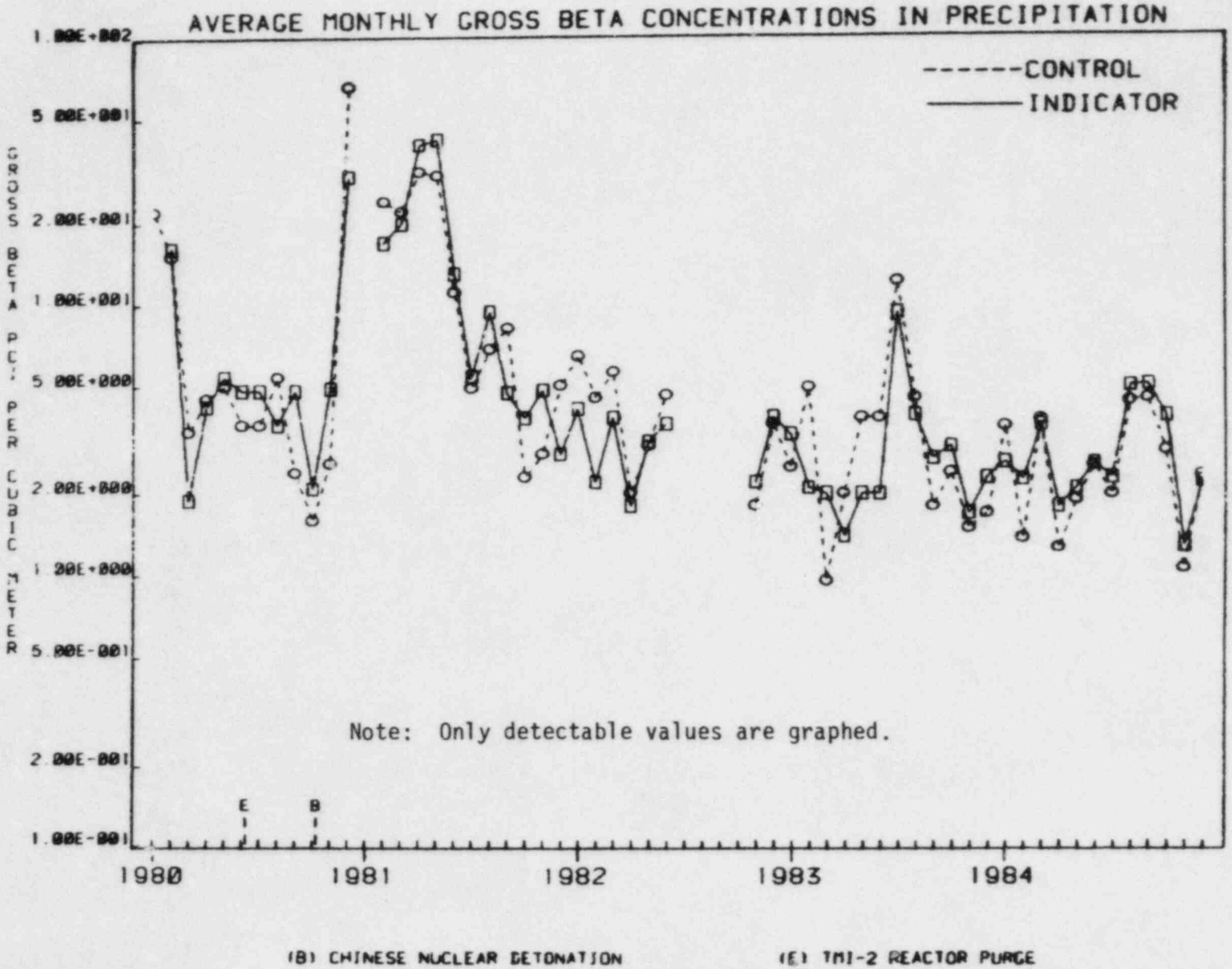
(pCi/L)

Station	Description	Average
E1-2 (I)	TMINS Observation Center	4.2
H3-1 (I)	Falmouth	2.5
A3-1 (I)	Middletown	2.1
Q15-1 (C)	West Fairview	3.1
G10-1 (C)	Drager Farm (Marietta)	2.2

(I) = Indicator Station

(C) = Control Station

FIGURE 14



AVERAGE MONTHLY GROSS BETA CONCENTRATIONS IN PRECIPITATION
------CONTROL
———INDICATOR
GROSS BETA PCI PER CUBIC METER
1.00E+002
5.00E+001
2.00E+001
1.00E+001
5.00E+000
2.00E+000
1.00E+000
5.00E-001
2.00E-001
1.00E-001
Note: Only detectable values are graphed.
E
B
1980
1981
1982
1983
1984
(B) CHINESE NUCLEAR DETONATION
(E) TMI-2 REACTOR PURGE

A3-1 (Middletown) had the highest yearly average of 170 pCi/L with a range of 130 to 240 pCi/L. Although a significant difference between indicator and control stations was indicated at the 95 percent confidence level ($P \leq 0.05$), all detected H-3 concentrations were consistent with established environmental levels. Quarterly averages for control and indicator stations are depicted in Figure 15.

The semiannual strontium analyses of precipitation samples revealed no detectable Sr-89 or Sr-90 for the 1984 monitoring period. Only naturally occurring Be-7 was detected in the quarterly gamma analyses.

4.3 Terrestrial Environment

The terrestrial environment around TMINS was examined by analyzing samples of milk from eight locations on a semimonthly/biweekly basis during 1984. Additionally, vegetables, fruits, broad leaf vegetation and soil samples were collected and analyzed.

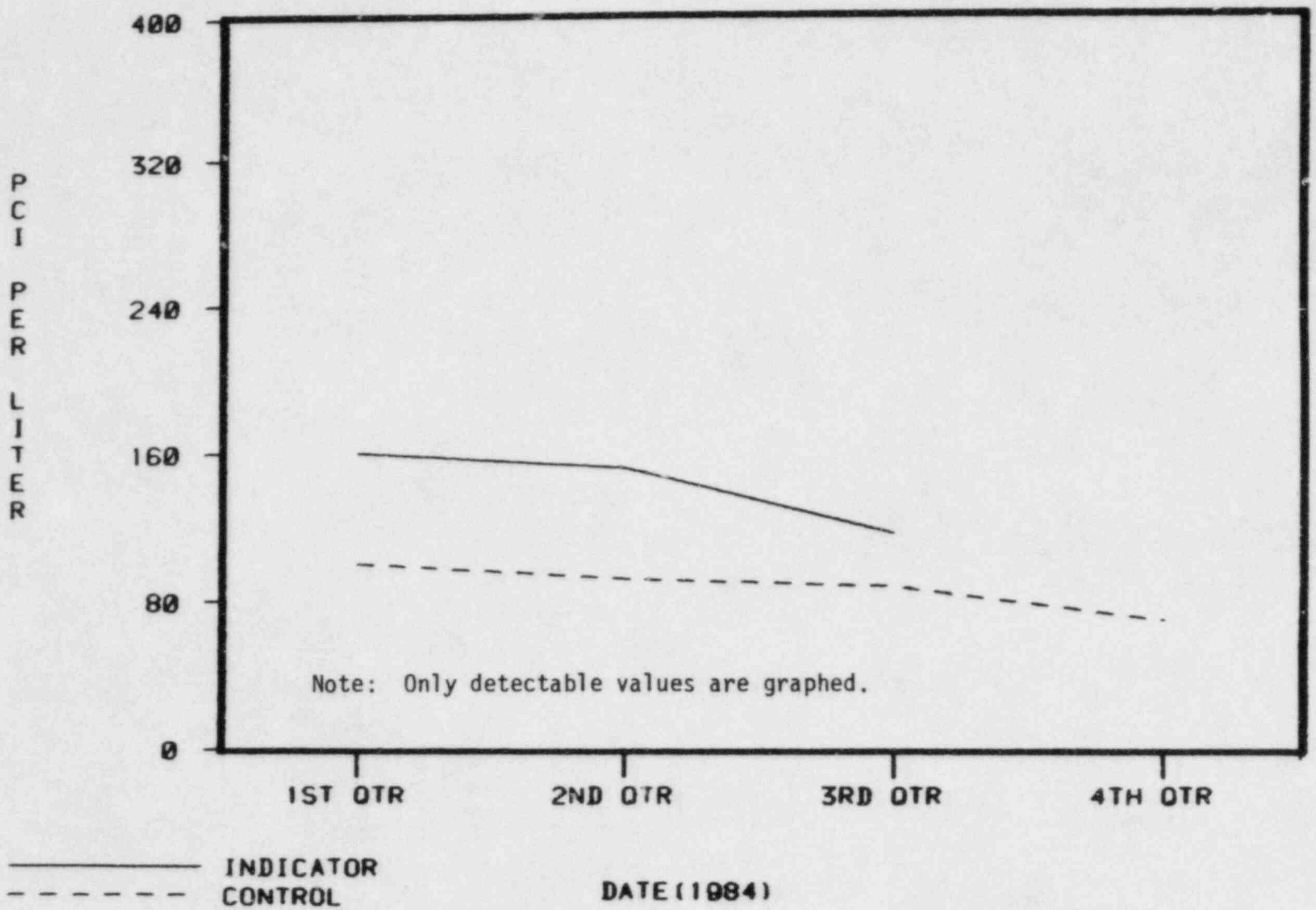
4.3.1 Milk

Cow and goat milk samples were collected semimonthly (twice per month) from January through March, then biweekly (every other week) for the remainder of the monitoring period. Samples were analyzed for I-131, gamma emitting radionuclides, Sr-89 and Sr-90.

Iodine-131 analysis was performed on each of the semimonthly/biweekly milk samples collected. No I-131 was detected in the main program samples. However, three

FIGURE 15

QUARTERLY TRITIUM CONCENTRATIONS IN PRECIPITATION



quality control samples contained anomolous concentrations of this radionuclide. All three values (.45 ± .21 pCi/L, .51 ± .25 pCi/L and .29 ± .20 pCi/L) were below the required Technical Specification LLD of 1.0 pCi/L. A duplicate analysis of the last sample was performed with a result of <0.47 pCi/L. These results are suspect since there is no known source for airborne I-131 including TMINS. The quality control laboratory was unable to verify the original results by a second counting technique.

The semimonthly/biweekly and monthly composite samples (January and February) were analyzed for gamma emitting radionuclides. Monthly compositing of milk samples was discontinued after February. Naturally occurring K-40 was found to be present in all goat and cow milk samples. Cesium-137 was only detected in goat milk samples collected in January at concentrations below the Technical Specification detection limit of 14.0 pCi/L. (Cow milk collected April 5 from control station A15-1 had detectable Cs-137 of 9.0 ± 3.8 pCi/L. However, the recount result was <8.0 pCi/L.)

Indicator goat milk collected January 5 and 19 contained detectable Cs-137 concentrations of 9.2 ± 3.5 pCi/L and 6.6 ± 3.7 pCi/L (recount, 12.7 ± 3.7 pCi/L), respectively. The quality control milk samples from these stations confirmed these results. The January monthly composites for both the main samples and the quality control samples contained positive levels as well. All detectable Cs-137 concentrations were consistent with the preoperational mean of 13.4 pCi/L and were a result of weapons fallout which has been incorporated into the feed and/or pasture grass.

Strontium analyses revealed only background levels of Sr-90 and questionable levels of Sr-89. The quality control laboratory reported Sr-89 in all four samples which were analyzed. However, upon reanalysis, Sr-89 was not detected in three of the four samples. As stated previously in this report, the quality control laboratory has had difficulty in performing the Sr-89 and Sr-90 analysis. The laboratory is currently evaluating this situation. Strontium-90, like Cs-137, is a product of nuclear weapons testing as well as reactor operations. Strontium 90 can enter plants by aerial deposition/surface absorption and/or root uptake from the deposit of Sr-90 in soil. Ingestion of the pasture grass and feed by milk-producing animals results in trace amounts of this radionuclide in the milk. Yearly Sr-90 averages for cow milk were 2.2 pCi/L and 2.7 pCi/L for indicator stations and the control station, respectively. Ranges were 0.7 pCi/L to 4.5 pCi/L for indicator stations and 2.0 pCi/L to 3.1 pCi/L for the control station. The cow milk station with the highest annual average was the control station, A15-1, with a mean of 2.7 pCi/L.

The Sr-90 detected in goat milk from the indicator station, A2-1, averaged 3.7 pCi/L with a range of 1.5 pCi/L to 5.2 pCi/L while the control station, D15-2, also averaged 3.7 pCi/L with a range of 1.7 pCi/L to 6.1 pCi/L.

Statistical analyses of the Sr-90 concentrations obtained during 1984 indicated that there was no significant difference at the 95 percent confidence level ($P \leq 0.05$) between cow milk indicator stations and the control station. The same was true for the goat milk indicator and control stations. All concentrations were consistent with the preoperational mean of 4.9 pCi/L and not related to TMINS operations.

Figures 16 and 17 depict trends in Sr-90 concentrations since 1980 in cow milk and goat milk, respectively. Generally, the Sr-90 concentrations in goat milk and cow milk have trended downward since 1983. This occurrence is related to the absence of recent atmospheric detonations of nuclear devices and the radioactive decay of both atmospheric and terrestrial Sr-90 associated with prior testing.

The dairy census was conducted as required by the Technical Specifications to determine the location of the nearest milk animal and to identify the locations of all milk animals in each of the 16 meteorological sectors out to a distance of five miles. The results are listed in Appendix G. There were no new locations identified which would yield a greater dose or dose commitment than at those dairy locations currently being sampled.

FIGURE 16

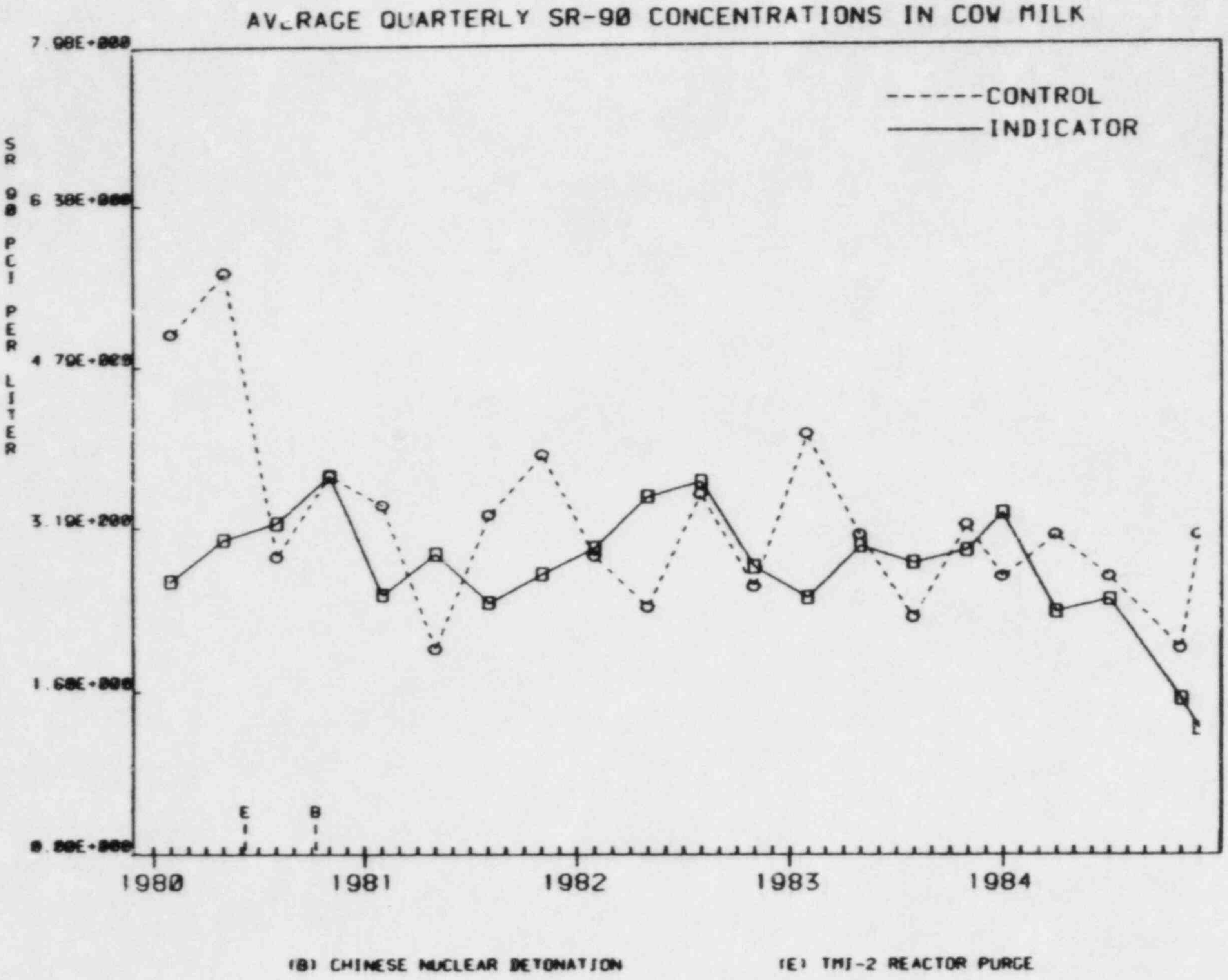
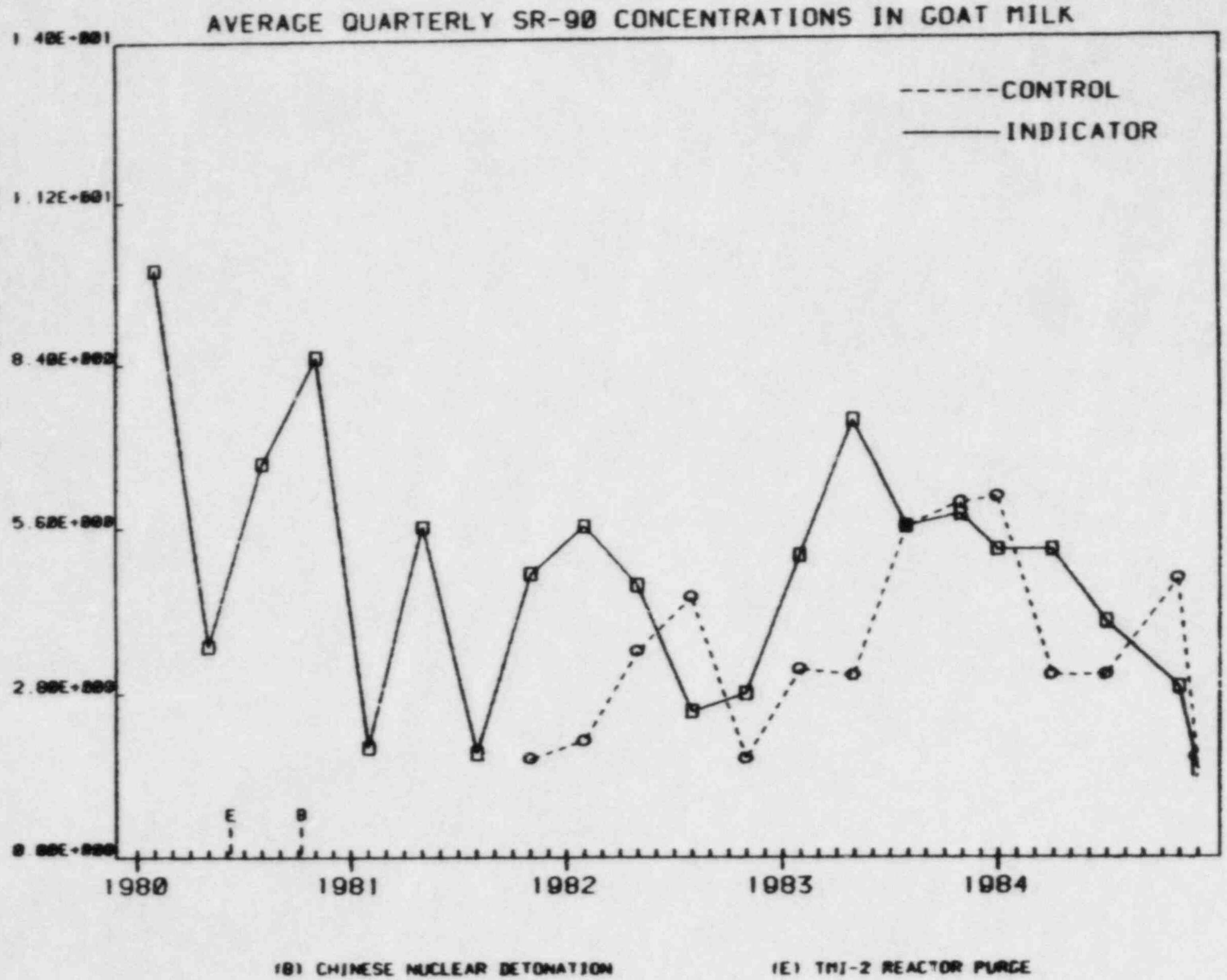

AVERAGE QUARTERLY SR-90 CONCENTRATIONS IN COW MILK
SR 90 PCI PER LITER
7.90E+000
6.30E+000
4.70E+000
3.10E+000
1.60E+000
0.00E+000
------CONTROL
———INDICATOR
E
B
1980
1981
1982
1983
1984
(B) CHINESE NUCLEAR DETONATION
(E) TMI-2 REACTOR PURGE

FIGURE 17



Note: The control goat milk station was not part of the REMP until the fourth quarter 1981.

4.3.2 Vegetables, Fruits, and Broad Leaf Vegetation

Analyses of food product samples and non-edible vegetation for gamma emitting radionuclides revealed naturally occurring K-40 and Be-7. One sample of broad leaf vegetation (seed lettuce) collected at indicator station D2-1 contained 0.013 ± 0.007 pCi/gm (wet) of Cs-137. This concentration was below the Technical Specification detection limit of 0.06 pCi/gm and was related to fallout from past atmospheric nuclear tests. None of the samples collected in 1984 contained any detectable I-131 or Cs-134.

The garden census was conducted as required by the Technical Specifications to determine the location of the nearest garden greater than 500 square feet producing broad leaf vegetation and to identify the locations of all gardens greater than 500 square feet producing broad leaf vegetation in each of the 16 meteorological sectors out to a distance of five miles. The results are listed in Appendix H. There were no new locations identified which would yield a greater dose or dose commitment than at those garden locations currently being sampled.

4.3.3 Soil

Soil samples were collected in May and December. Analyses performed were gamma isotopic and Sr-89 and Sr-90. Gamma analyses yielded detectable levels of naturally occurring K-40, Ra-226, and Th-228 as well as fallout-related

Cs-137 in both indicator and control stations. The average Cs-137 concentrations in soil for indicator and control stations were 0.30 and 0.61 pCi/gm (dry), respectively.

With the exception of one quality control sample, no Sr-89 was detected. This result was not considered valid for reasons discussed in Section 4.1.4. Strontium-90 was detected in 11 of 22 samples collected. Indicator stations averaged 0.054 pCi/gm (dry) ranging from 0.011 - 0.160 pCi/gm (dry) while control stations averaged 0.087 pCi/gm (dry) with a range of 0.030 - 0.150 pCi/gm (dry).

All Cs-137 and Sr-90 concentrations detected in 1984 soil samples are consistent with 1974 preoperational levels of 0.63 pCi/gm (dry) and 0.72 pCi/gm (dry) for Cs-137 and Sr-90, respectively. The presence of these radionuclides was unrelated to TMINS operations.

4.4 Direct Radiation

Ambient radiation levels in the vicinity of TMINS were determined with thermoluminescent dosimeters (TLD). A TLD is a small (matchbook size), sensitive monitoring device used to determine exposure levels of x-ray and gamma radiation. Each TLD contains four small phosphors or "chips" which store the energy incident on them. During analysis, the stored energy is released in the form of light through a carefully controlled heating process. The measured light output is directly proportional to the absorbed radiation dose. This device is able to accurately detect exposures ranging from 1 mR to 200 R.

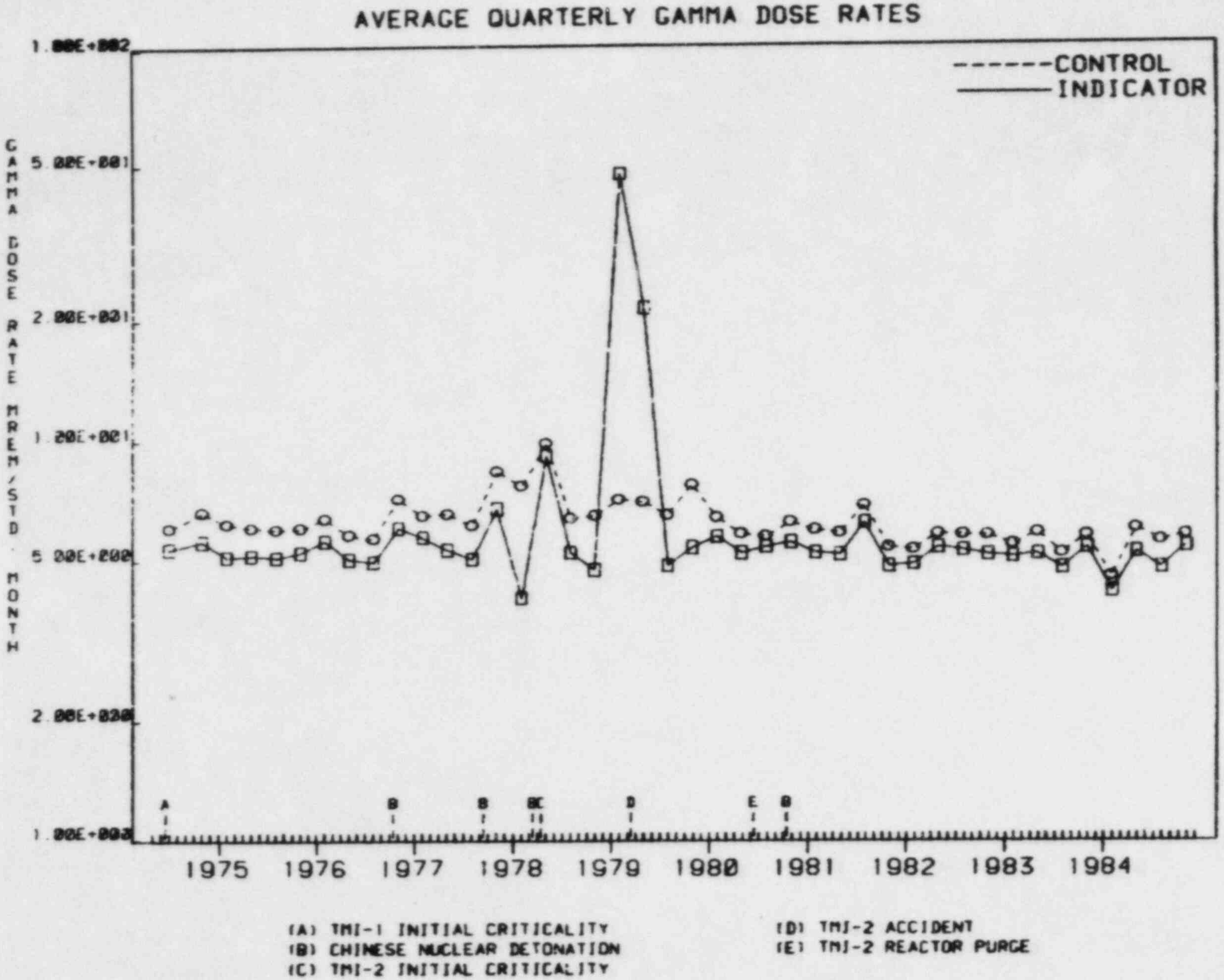
During 1984, TLD's were collected on a quarterly basis from locations ranging in distance from less than 0.1 miles to 21.1 miles from TMINS. Thirteen (13) new stations, all of which are located on TMI, were added to the TLD network during the second quarter. All TLD data presented in this report have been normalized to a standard month (30.4 days) to eliminate the differences in exposure periods. Exposure rates (mR/standard month) are considered numerically equal to dose rates (mrem/standard month) for this report.

Of the four phosphors in each TLD, two are composed of calcium sulfate and two of lithium borate. The calcium sulfate phosphors are shielded with lead making them sensitive to penetrating (gamma) radiation only. The two lithium borate phosphors are shielded differently to permit the detection of beta as well as gamma radiation. Typically, only the calcium sulfate phosphors are used to determine the environmental dose from penetrating radiation. However, during the second, third, and fourth quarters, the lithium borate phosphors had to be used for this determination. This action was prompted by the discovery that the lead shields used to cover the calcium sulfate phosphors had been contaminated, during manufacture, with fallout radioactivity. The contaminated lead caused a self-irradiation of the phosphors leading to erroneous environmental readings. Use of the lithium borate phosphors did not result in a diminished capacity to determine the environmental dose due to penetrating radiation.

Average gamma dose rates in the vicinity of TMINS from 1974 through 1984 are presented in Figure 18. In 1984 data obtained from indicator stations, those stations located less than 10 miles from TMINS, yielded an annual average dose rate of 4.9 mrem/standard month with a range of 2.8 to 9.2 mrem/standard month. Control stations ranged from 3.6 to 8.0 mrem/standard month and averaged 5.5 mrem/standard month. In 1983 these values were 5.1 mrem/standard month and 5.6 mrem/standard month for indicator and control stations respectively. The station with the highest annual average was indicator station F1-2 which is located on TMINS. The annual average dose rate for this location was 7.4 mrem/standard month which equates to 89 mrem/year. This value is consistent with the USEPA calculated annual dose equivalent of 88 mrem for the Harrisburg area due to natural radiation from the environment (26). Since Station F1-2 along with 12 others are new to the Environmental TLD network, no historic data are available. The dose rate at this station compares to control station G10-1 which yielded the next highest average dose rate of 7.1 mrem/standard month. This equates to approximately 85 mrem/year, and is consistent with the USEPA calculated annual dose equivalent of 88 mrem for the Harrisburg area.

Statistical analyses of the TLD data indicated that there were significant differences ($P \leq 0.05$) between exposure rates at individual stations. Differences also were evident between indicator and control groups with the indicator being consistently lower than

FIGURE 18



AVERAGE QUARTERLY GAMMA DOSE RATES
------CONTROL
———INDICATOR
GAMMA DOSE RATE MREM/STD MONTH
1.00E+002
5.00E+001
2.00E+001
1.00E+001
5.00E+000
2.00E+000
1.00E+000
A
B
B
BC
D
E
B
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
(A) TMI-1 INITIAL CRITICALITY
(B) CHINESE NUCLEAR DETONATION
(C) TMI-2 INITIAL CRITICALITY
(D) TMI-2 ACCIDENT
(E) TMI-2 REACTOR PURGE

background. This may be seen from the quarterly trends in TLD data displayed in Figure 19. The correlation coefficient between indicator and control station data was calculated to be 0.93. The differences between stations were attributed to variations in the natural radioactivity content of the rocks and soil in the immediate vicinity of each station.

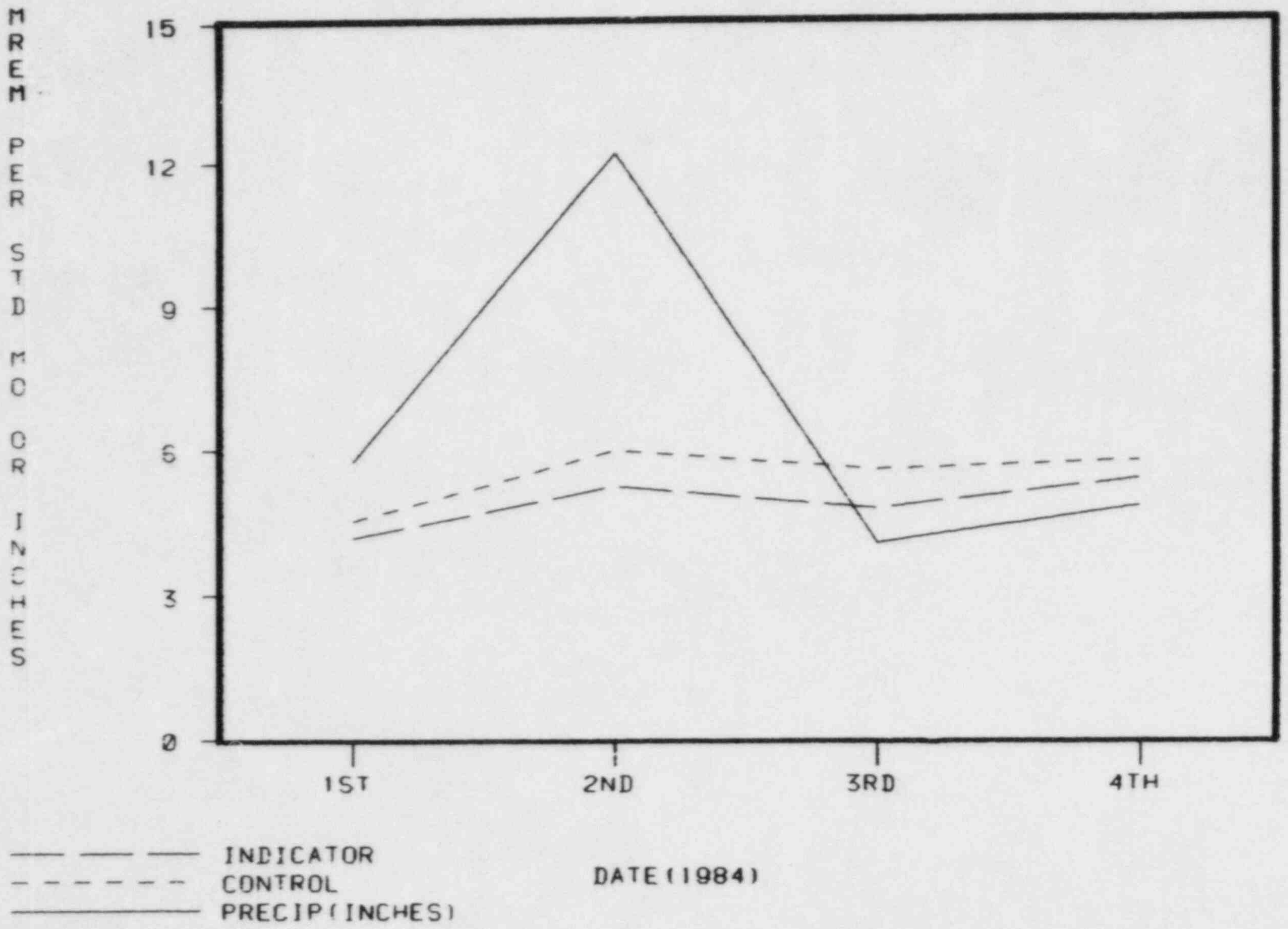
Average quarterly dose rates for both indicator and control stations increased slightly in the second and fourth quarters while a diminution was realized in the first quarter. A similar trend was noted in precipitation data during 1984. This relationship is plotted in Figure 19. The fluctuations in the quarterly dose rates were most likely a result of atmospheric washout due to precipitation.

Radioactive debris from nuclear explosions will remain suspended at high altitudes for long periods of time. Due to enhanced stratospheric-tropospheric exchange during spring and fall, increases in exposure rates are anticipated. Rainfall removes radioactive particles from the troposphere primarily by droplet formation around the particle (rainout) and also by a scrubbing action (washout).

All values recorded during 1984 were found to be within normal background ranges. No evidence was found that would indicate a relationship between TMINS operations and any of the exposure rates that were recorded by TLD's. Appendix M presents the 1984 results from the indivdual TLD stations in tabular and graphical forms. A

FIGURE 19

QUARTERLY GAMMA DOSE RATES VS PRECIPITATION



distribution graph of dose rates is also included. Evaluation of this data indicated that the majority of dose rates in the TMINS vicinity range from 4.0 to 5.5 mrem/standard month.

4.5 Quality Assurance Program

The TMI Environmental Controls Quality Assurance (QA) program consists of: (1) splitting samples and having them analyzed as if they were obtained at separate stations, (2) requiring contractor laboratories to participate in the USEPA Cross-Check Program, (3) requiring contractor laboratories to perform duplicate analyses on every tenth sample, and (4) auditing the contractor laboratory facilities. See Appendices E and F for the results.

In addition, the TMI REMP is audited by the USNRC and GPU Nuclear Quality Assurance department to assure compliance with the Technical Specifications, applicable federal regulations, and policies and procedures of GPU Nuclear Corporation.

5.0 ASSESSMENT OF IMPACT

The gaseous and liquid effluent streams from TMI-1 and TMI-2 were continuously monitored and/or sampled by GPU Nuclear for the presence of radioactive materials. (Refer to Appendix I for dose analysis based on effluent data.) The REMP was designed and conducted in a manner to ensure identification of the radionuclides actually released from the station. This REMP data was compared to the TMINS effluent data.

Small quantities of Sr-90, Cs-137, and H-3 were released from TMINS during 1984. The actual amounts as determined by the effluent sampling program were well below the federal limits. These same radionuclides were detected in environmental samples, but the concentrations detected were indistinguishable from levels resulting from past detonations of nuclear explosive devices. It is concluded that there was no adverse impact on the environment as a result of TMINS operations.

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(21) GPU Nuclear Corporation. "Final Safety Analysis Report, Three Mile Island Nuclear Station, Unit 1," 1982.

(22) Metropolitan Edison Company. "Final Safety Analysis Report, Three Mile Island Nuclear Station, Unit 2," 1978.

(23) Teledyne Isotopes. "Procedures and Quality Assurance Handbook." IWL-00320365, 1975.

(24) Radiation Management Corporation. "Analytical and Quality Control Program." RMC-TM-75-3, 1975.

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(27) United States Nuclear Regulatory Commission. Regulatory Guide 1.109, Calculations of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

APPENDIX A

1984 REMP Sampling Locations and Descriptions

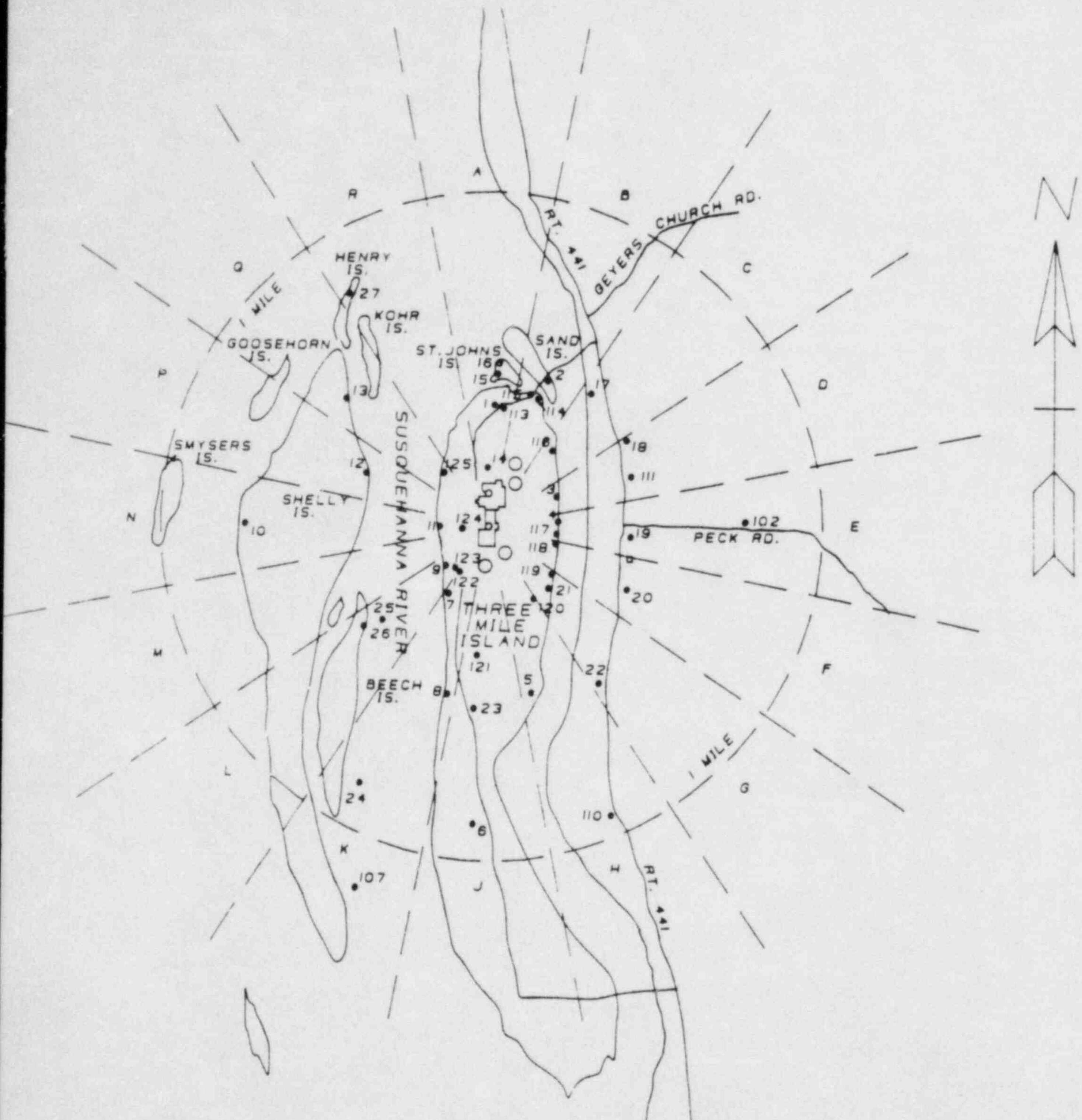


FIGURE A-1

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)
STATIONS APPROXIMATELY 1 MILE FROM THE SITE

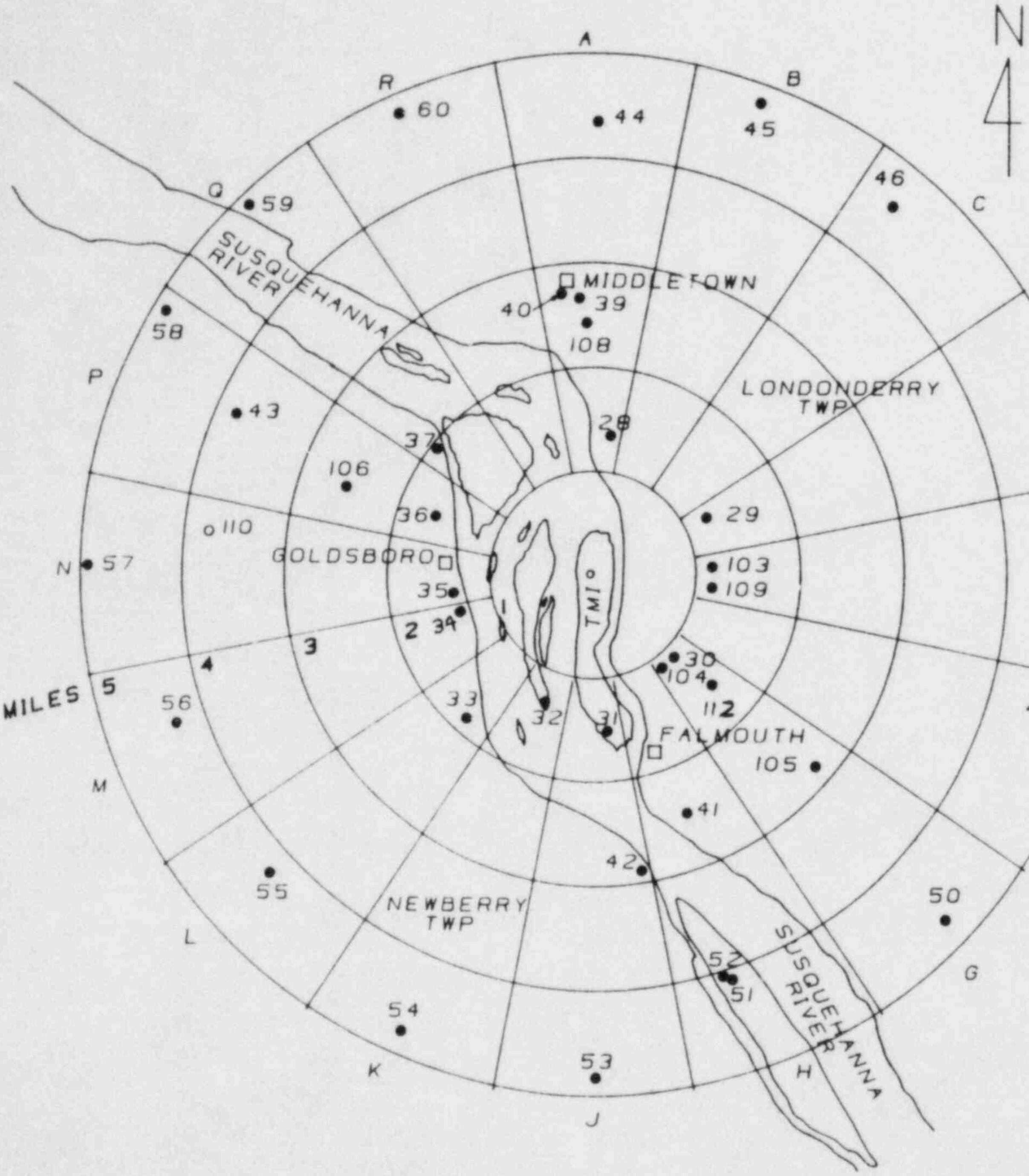


FIGURE A-2

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)
STATIONS WITHIN 5 MILES OF THE SITE

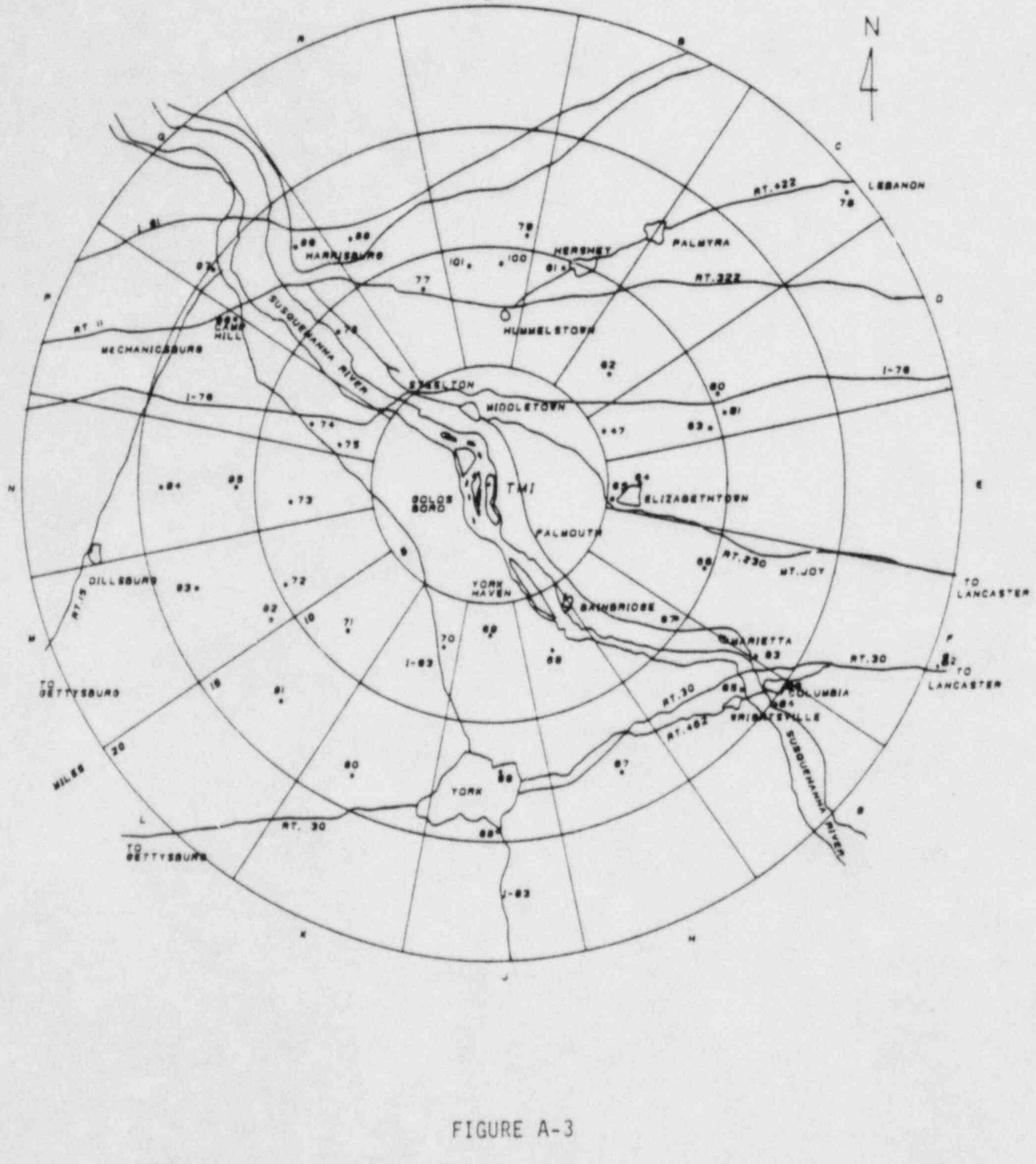


FIGURE A-3

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)
STATIONS GREATER THAN 5 MILES FROM SITE

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE LOCATION

Sample Medium	Station Code	Map Number	Distance	Azimuth	Description
AP,AI,ID	A1-1	1	0.4 mi	0^{o}	N of site, North Weather Station, TMI
ID	A1-4	113	0.4	2	N of Reactor Building on W. Fence adjacent to N. Weather Station TMI
ID	B1-1	2	0.7	25	NNE of site on light pole in middle of North Bridge TMI
ID	B1-2	114	0.4	26	NNE of Reactor Building at top of dike TMI
ID	B1-3	115	0.5	15	NNE of Reactor Building on fence adjacent to S end of N Bridge TMI
ID	C1-2	116	0.3	45	NE of Reactor Building at top of dike TMI
ID	D1-1	3	0.3	71	ENE of site on top of dike, east fence TMI
ID	E1-1	4	0.2	95	E of site on top of dike, east fence TMI
ID	E1-4	117	0.2	90	E of Reactor Building at top of dike TMI
ID	F1-2	118	0.2	102	ESE of Reactor Building at top of dike midway within interim Solid Waste Staging Facility TMI
ID	G1-3	119	0.3	124	SE of Reactor Building at top of dike TMI
ID	H1-1	5	0.4	167	SSE TMI
ID	H1-9	120	0.3	148	SSE of Reactor Building at top of dike TMI
ID	J1-1	6	0.8	184	S TMI
ID	J1-3	121	0.3	185	S of Reactor Building on wooden post next to mailroom TMI
EW	K1-1	7	0.2	200	On site, RML-7 station discharge
ID	K1-2	8	0.4	195	SSW TMI
ID	K1-5	122	0.2	202	SSW of Reactor Building on fence behind Warehouse 3 TMI
ID	K1-4	123	0.2	208	SSW of Reactor Building on fence behind Warehouse 2 TMI
ID	L1-1	9	0.1	221	SW of site, west of mechanical draft towers on dike TMI
ID	N1-1	10	0.4	270	W of site on Shelley Island
ID	N1-3	124	0.1	270	W of Reactor Building on fence adjacent to screenhouse entrance gate TMI
SW	N1-2A/B	11	0.1	270	On site, station intake (Unit 1 and Unit 2)
ID	P1-1	12	0.4	293	WNW of site on Shelley Island
ID	Q1-1	13	0.5	317	NW of site on Shelley Island

TABLE A-1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE LOCATION

Sample Medium	Station Code	Map Number	Distance	Azimuth	Description
ID	Q1-2	125	0.2 mi	325°	NW of Reactor Building on fence behind Warehouse 1 TMI
ID	R1-1	14	0.2	340	NNW of site at gate in fence on W side of TMI, north boat dock
AQS	A1-2	15	0.7	1	N of site at north tip of TMI
AQS	A1-3	16	0.7	0	N of site at north tip of TMI
ID	C1-1	17	0.6	35	NE of site on Route 441 N.
ID	D1-2	18	0.5	65	ENE of site on Laurel Road
AP,AI,RW,ID,CR,S	E1-2	19	0.4	90	E of site on N side of Observation Center
ID	F1-1	20	0.5	117	ESE of site on light pole at entrance to 500 Kev Substation
AQS	G1-1	21	0.3	137	SE of site
ID	G1-2	22	0.6	143	SE of site on Route 441 S.
SW	J1-2	23	0.5	188	S of site below discharge pipe west shore TMI
AQS	K1-3	24	0.8	202	SSW of site
AQS	L1-3	25	0.5	225	SW of site
ID	L1-2	26	0.5	221	SW of site on Beech Island
ID	R1-2	27	0.7	332	NNW of site on Henry Island
MG,FPL	A2-1	28	1.2	5	N of site, farm along Route 441
M,FPL,S	D2-1	29	1.1	65	ENE of site, farm on Gingrich Road
M,FPL	G2-1	30	1.6	130	SE of site, farm on the E side of Conewago Creek
SW,AQS	J2-1	31	1.5	182	S of site above York Haven Dam TMI
ID	K2-1	32	1.1	200	SSW of site on S Shelley Island
ID	L2-1	33	1.9	227	SW of site on Route 262
AP,AI,ID,CR	M2-1	34	1.3	253	WSW of site adjacent to Fishing Creek, Goldsboro Sub Station
ID	N2-1	35	1.2	262	W of site at Goldsboro Marina
ID	P2-1	36	1.6	297	WNW of site off of Old Goldsboro Pike
ID	Q2-1	37	1.8	310	NW of site on access road along river
AP,AI,ID,RW,CR	A3-1	39	2.6	358	N of site at Middletown Substation

TABLE A-1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE LOCATION

Sample Medium	Station Code	Map Number	Distance	Azimuth	Description
SW	A3-2	40	2.5 mi	355°	N of site of Swatara Creek
AP,AI,RW, ID,CR	H3-1	41	2.3	159	SSE of site at Falmouth-Collins Substation
SW	H3-2	42	2.3	165	SSE of site, York Haven Hydro
M,FPL	P4-1	43	3.6	295	WNW of site at Fisher's farm on Valley Road
ID	A5-1	44	4.3	3	N of site on Vine Street Exit from Route 283
ID	B5-1	45	4.8	18	NNE of site, School House Lane and Miller Road
ID	C5-1	46	4.5	42	NE of site on Kennedy Lane
ID	D6-1	47	5.2	65	ENE of site off Beagle Road
ID	E5-1	48	4.6	81	E of site, North Market Street and Zeager Road
ID	F5-1	49	4.7	107	ESE of site on Amosite Road
ID	G5-1	50	4.8	131	SE of site, Bainbridge and Risser Roads
SW	H5-2	51	4.1	160	SSE of site on Brunner Island
ID	H5-1	52	4.1	157	SSE of site Guard Shack on Brunner Island
ID	J5-1	53	4.9	182	S of site on Canal Road, Conewago Heights
ID	K5-1	54	5.0	200	SSW of site on Conewago Creek Road, Strinestown
ID	L5-1	55	4.1	228	SW of site, Stevens and Wilson Roads
ID	M5-1	56	4.3	249	WSW of site, Lewisberry and Roxberry Roads, Newberrytown
ID	N5-1	57	4.9	268	W of site, off of Old York Road and Robin Hood Drive
ID	P5-1	58	4.9	281	WNW of site, Route 262 and Beinhower Road
ID	Q5-1	59	5.0	318	NW of site on Lumber Street, Highspire
ID	R5-1	60	4.9	339	NNW of site, Spring Garden Drive and Route 441
ID	B10-1	61	9.4	21	NNW of site, West Areba Avenue and Mill Street, Hershey
ID	C8-1	62	7.2	48	NE of site, Schenk's Church on School House Road
ID	D9-1	63	8.5	72	ENE of site on Mt. Gretna Road, Bellaire
ID	E7-1	64	6.8	86	E of site on Hummelstown Street, Elizabethtown
FPF	E6-1	65	5.9	100	E of site, orchard at Masonic Homes
ID	F10-1	66	9.4	112	ESE of site, Donegal Springs Road, Donegal Springs
AP,AI,RW,ID,S	G10-1	67	9.8	127	SE of site at farm off Engle's Tollgate Road
ID	H8-1	68	7.4	163	SSE of site on Saginaw Road, Starview
ID	J7-1	69	6.5	177	S of site on Maple Street, Manchester

TABLE A-1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE LOCATION

Sample Medium	Station Code	Map Number	Distance	Azimuth	Description
ID	K8-1	70	7.4 mi	196°	SSW of site, Coppenhaffer Road and Route 295, Zion's View
ID	L8-1	71	8.0	225	SW of site on Rohler's Church Rd., Andersontown
ID	M9-1	72	8.6	242	WSW of site on Alpine Road, Maytown
ID	N8-1	73	7.8	260	W of site on Route 382, 1/2 mile north of Lewisberry
ID	P8-1	74	8.0	292	WNW of site on Evergreen Road, Resser's Summit
M	P7-1	75	6.7	293	WNW of site on Old York Road, New Cumberland
SW,ID	Q9-1	76	8.5	308	NW of site across from parking lot of Steelton Water Company
ID	R9-1	77	8.1	340	NNW of site on Derry Street and 66th Street, Rutherford Heights
M,FPL	A15-1	78	10.5	10	NNE of site, farm on Route 39, Hummelstown
ID	C20-1	79	19.6	47	NE of site on Cumberland Street, Lebanon
ID	D15-1	80	10.9	63	ENE of site, Route 241, Lawn, PA
MG,FPL	D15-2	81	10.0	68	ENE of site, Route 241, 200 meters south of PA Turnpike, Davidhizer Farm
ID	F25-1	82	21.1	113	ESE of site, Steel Way and Loop Roads, Lancaster
SW	F15-1	83	12.6	122	ESE of site, Chickies Creek
SW,ID	G15-1	84	14.4	124	SE of site at Columbia Water Treatment Plant
SW	G15-2	85	13.6	128	SE of site, Wrightsville Water Treatment Plant
SW	G15-3	86	14.8	124	SE of site, Lancaster Water Treatment Plant
ID	H15-1	87	13.2	157	SSE of site, Orchard and Stonewood Roads, Wilshire Hills
AP,AI,ID	J15-1	88	12.6	180	S of site in Met-Ed York Load Dispatch Station
SW	J15-2	89	14.7	178	S of site at York Water Company
ID	K15-1	90	12.7	204	SSW of site, Alta Vista Road, Weiglestown at Dover Township Fire Department Bldg.
ID	L15-1	91	11.7	225	SW of site on west side of Route 74, Mt. Royal
ID	M15-1	92	11.9	237	WSW of site, west side of Route 74, in front of Earth Crafts, Rossville

TABLE A-1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE LOCATION

Sample Medium	Station Code	Map Number	Distance	Azimuth	Description
FPF	M15-2	93	13.6 mi	253°	WSW of site on W side of Route 74, Lerew's orchard
ID	N15-1	94	13.2	276	W of site, Orchard Lane and Hertzler Road, Mt. Allen
ID	N15-2	95	10.4	274	W of site, Lisburn Road and Main Street, Lisburn
ID	P15-1	96	12.2	300	WNW of site on Erford Road in front of Penn Harris Motel, Camp Hill
AP,AI,RW,ID,S	Q15-1	97	13.5	305	NW of site at West Fairview Substation
ID	Q15-2	98	11.5	310	NW of site, Penn and Forster Streets, Harrisburg
ID	R15-1	99	11.2	330	NNW of site, Route 22 and Colonial Road, Colonial Park
S	A9-1	100	9.2	0	N of site off of Union Deposit Road
FPL,S	A9-2	101	9.3	357	N of site on Union Deposit Road, W of Hoernerstown
FPL	E1-3	102	0.7	90	E of site, 100 m W of Peck Road and Zion Road intersection
FPL,S	E2-1	103	1.1	80	E of site on Zion Road
S	G2-2	104	1.3	133	SE of site on Engle Road
S	G3-1	105	2.8	131	SE of site on Governor's Stable Road intersection with Keener Road
FPL	P3-1	106	2.6	293	WNW of site on Route 392 (Yocumtown Road)
AQF,AQP	Indicator		-	-	All locations where fish and plants are collected below the discharge are grouped together and referred to as "indicator"
AQF,AQP	Control	-	-	-	All locations where fish and plants are collected above the discharge are grouped together and referred to as "control"
AQS	K2-2	107	1.1	197	SSW of site E of Shelley Island
S	A3-3	108	2.5	354	N of site at junction of Swatara Creek and Route 441
M	E2-2	109	1.1	93	E of site farm on Peck Road
FPL,FPF	H1-2	110	0.9	150	SSE of site stand off of Rt. 441 S.
FPF	D1-3	111	0.5	65	ENE of site house next to Yinger's Greenhouse
S	G2-3	112	1.6	132	SE of site near Conewago Cr.

TABLE A-1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE LOCATION

IDENTIFICATION KEY

ID = Immersion Dose (TLD)	CR = Cryogenic Air Sampler	AQF = Fish
SW = Surface Water	RW = Rain Water	AQP = Aquatic Plants
AI = Air Iodine	M = Milk (Cow)	AQS = Aquatic Sediment
AP = Air Particulate	MG = Milk (Goat)	FPL = Green Leafy Vegetation or Vegetables
S = Soil	EW = Effluent Water	FPF = Fruit

APPENDIX B

1984 LLD Exceptions

TABLE B-1

TECHNICAL SPECIFICATIONS ANALYTICAL RESULTS WHICH FAILED TO MEET THE REQUIRED LLD DURING 1984

Sample Media	Analysis	Required LLD	No. of Samples Out of Compliance	Comments
Air Iodine	I-131	0.07 pCi/M^3	1	Sampler malfunction (blown fuse)
Air Particulate	Gr-β	0.01 pCi/M^3	1	Sampler malfunction (blown fuse)

APPENDIX C

Changes Effected in the 1984 REMP

March 13, 1984	Quarterly composite gamma analyses eliminated for air particulates - All stations. (Monthly composite gamma analyses retained)
	Quarterly composite tritium analyses eliminated for surface, drinking, intake and effluent water - All stations. (Monthly tritium analyses retained)
	Monthly composite gamma analyses eliminated for goat and cow milk - All stations. (Biweekly gamma analyses retained)
	Biweekly and quarterly composite P-32 analyses eliminated for intake and effluent water - All stations. (Monthly composite P-32 analyses retained)
	Quarterly composite Fe-55 analyses eliminated for intake and effluent water - All stations. (Monthly composite Fe-55 analyses retained)
	Intake station N1-2B and QC sample N1-2BQ eliminated.
March 31, 1985	Thirteen (13) additional TLD stations taken over by TMI Environmental Controls from TMI Dosimetry.
April 26, 1984	Water station J15-2 (York Water Co.) changed from indicator to background. This change was made since water is obtained from a tributary (Codorus Creek) of the Susquehanna River.
June 20, 1984	Weekly gross alpha analyses on air particulate filters initiated to monitor TMI-2 headlift operations.
August 8, 1984	Terminated weekly gross alpha analysis on air particulate filters.
November 30, 1984	Relocated precipitation collector at the TMI Observation Center (E1-2) to an area free of overhanging vegetation/objects.

APPENDIX D

Determination of Investigational Levels

and Subsequent Levels

Analysis of environmental samples and the analytical data generated are routinely evaluated by the TMI Environmental Controls staff. Based on the comparisons of values from indicator and control stations, investigations are initiated and appropriate actions are implemented. The following protocol is utilized:

The investigational level (IL) for REMP results is determined by two methods:

1. Single control station - the appropriate control station for the sample medium is selected.

   IL = Control Concentrations + 3.1 σ = x + 3.1 σ. If any indicator station concentration is greater than x + 3.1 σ, an investigational level has been reached.

2. Multiple Control Stations - the appropriate control stations for the sample medium are selected. IL = Average of Control Concentrations + 3.1 standard deviations (s.d.) = $\bar{x}$ + 3.1 s.d. If any indicator station concentration is greater than $\bar{x}$ + 3.1 s.d., an investigational level has been reached.

Appropriate actions which are implemented include some or all of the following:

1. Examination of collection sheets for notations regarding equipment malfunctions.
2. Examination of collection sheets for sample collection or delivery problems.
3. Recount of sample.
4. Reanalysis of sample.
5. Collection of an additional sample.

In addition to examining the data for investigational levels, all data are checked for LLD violations, anomalous values, Technical Specifications reporting levels, late analysis results, and main sample and "Q" sample agreement (Appendix E).

APPENDIX E

1984 Quality Assurance Results

The TMI Environmental Controls Quality Assurance (QA) Program consists of three phases. Phase I consists of splitting samples collected at designated stations and analyzing them as if they were obtained at separate stations. Analysis results from the "Q" station are compared to those from the main station by criteria set forth in TMI Environmental Controls procedure 9420-SUR-4523.03. Agreement is considered acceptable if the coefficient of variation for the two values is eighty five percent or less. Non-agreement of the values, results in recounting or reanalyzing the samples in question. Phase II requires that laboratories analyzing environmental samples from TMINS participate in the USEPA Cross-Check Program. This serves as independent verification of their ability to correctly analyze environmental samples. Results of this interlaboratory comparison program are presented in Appendix F. Phase III requires that contractor laboratories perform duplicate analyses on every tenth sample. Results of the two analyses are checked to verify agreement.

Table E-1 outlines the split sample portion of the QA program for the media collected during 1984. Sixteen QA non-agreements occurred during the entire year. They are presented in Table E-2 along with corrective actions taken. Quality assurance non-agreements occurred most frequently in the analysis of Sr-89/90. The quality control laboratory has had difficulty analyzing these radionuclides, and is currently evaluating this situation.

TABLE E-1

QA SAMPLE PROGRAM

Sample Medium	No. of Regular Stations	No. of QA Stations	Percentage of Regular Samples Submitted for QA Analysis
Air Particulate (AP)	8	2	25 percent
Air Iodine (AI)	8	2	25 percent
Surface/Drinking Water (SW/DW)	17*	5*	29 percent
Milk (M/MG)	8	2	25 percent
Precipitation (RW)	5	2	40 percent
TLD's Quarterly (ID)	86	19	22 percent
Aquatic Plants (AQP)	2	1	50 percent
Aquatic Sediment (AQS)	3	1	33 percent
Fish (AQF)	4	2	50 percent
Food Products (FPV,FPF,FPL)	13	4	31 percent
Soil (S)	11	2	18 percent

* Includes sampling station at TMINS Discharge.

TABLE E-2

QA NON-AGREEMENTS

Sample Medium	Collection Dates	Station	Analysis	Action
AP	01/11-01/18	G10-1 G10-1Q	Gr-β	Comment 1
AP	02/22-02/29	G10-1 G10-1Q	Gr-β	Comment 2
AP	10/03-10/10	G10-1 G10-1Q	Gr-β	Comment 3
EW	09/27-10/25	K1-1 K1-1Q	H-3	Comment 4
EW	07/26-08/30	K1-1 K1-1Q	Fe-55	Comment 4
SW	06/28-07/26	G15-1 G15-1Q	H-3	Comment 4
SW	08/30-09/27	J2-1 J2-1Q	Gr-β	Comment 4
M	4th Quarter	G2-1 G2-1Q	Sr-90	Comment 4
AQS	07/31	J2-1 J2-1Q	Sr-89	Comment 4
AQF	09/27-10/11	Indicator (Predator) Indicator (Predator)-Q	Sr-90	Comment 5
AQP	07/31	Indicator Indicator-Q	Sr-89,Sr-90	Comment 5
AQP	10/18	Control Control-Q	Sr-89,Sr-90	Comment 5

TABLE E-2

QA NON-AGREEMENTS (Continued)

Sample Medium	Collection Dates	Station	Analysis	Action
S	12/04	G2-3 G2-3Q	Sr-90	Comment 5
S	12/04	Q15-1 Q15-1Q	Sr-90	Comment 5

COMMENTS:

1. Recounts performed. Second counts confirmed original results. Samples are obtained by two separate samplers.

2. Calculational error by laboratory. Results were within limits of agreement.

3. Primary sample contained small amount of particulate matter, probably due to a sample handling problem. No action initiated.

4. Reanalysis performed. Reanalysis results were within limits of agreement.

5. No reanalysis requested. QC laboratory having difficulty in analyzing for Sr-89 and Sr-90.

APPENDIX F

1984 EPA Cross-Check Results

The Technical Specifications for Three Mile Island require that the results of licensee participation in the Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies (Cross-Check) Program be presented in the annual report. The purpose of participation in this program is to provide an independent check on the laboratory's analytical procedures and to alert it to any possible problems. This section contains those results for 1984. Results from both laboratories were found to be within acceptable ranges with the exception of 13 percent and 19 percent of the analyses for the primary laboratory and the quality control laboratory, respectively. Investigations were initiated for those exceptions.

Primary Laboratory

Results

TABLE F-1

US EPA CROSS-CHECK PROGRAM 1984

Collection Date	Media	Nuclide	EPA-Results(A)	Teledyne Isotopes Results(B)
01/06	Water	Sr-89	36. ± 8.7	29.3 ± 8.7
		Sr-90	24. ± 2.6	23. ± 3.
01/13	Water	Plutonium	18.8 ± 3.3	14.2 ± 3.3
01/20	Water	Gross Alpha	10. ± 8.7	8. ± 3.
		Gross Beta	12. ± 8.7	12. ± 3.
01/27	Food	Sr-89	34. ± 8.7	33.3 ± 1.7
		Sr-90	20. ± 8.7	21.7 ± 1.7
		I-131	20. ± 10.4	16.3 ± 1.7
		Cs-137	20. ± 8.7	24.1 ± 0.6
		K	2720. ±235.	2503. ±555.
02/03	Water	Cr-51	40. ± 8.7	L.T. 80.
		Co-60	10. ± 8.7	15. ± 7.9
		Zn-65	50. ± 8.7	53.3 ± 16.5
		Ru-106	61. ± 8.7	58.7 ± 33.
		Cs-134	31. ± 8.7	33.3 ± 3.
		Cs-137	16. ± 8.7	19.3 ± 1.7
02/10	Water	H-3	2383. ±607.	2270. ±786.
02/17	Water	U	15. ± 10.	14. ± 4.6
03/02	Milk	I-131	6. ± 1.6	5.7 ± 1.7
03/09	Water	Ra-226	4.1 ± 1.06	5.66 ± 1.5
		Ra-228	2.0 ± 0.52	L.T. 4.1
03/16	Water	Gross Alpha	5. ± 8.7	5. ± 1.3
		Gross Beta	20. ± 8.7	20. ± 3.
03/23	Air Filter	Gross Alpha	15. ± 8.7	19. ± 1.7
		Gross Beta	51. ± 8.7	45. ± 3.0
		Sr-90	21. ± 2.6	20. ± 6.0
		Cs-137	10. ± 8.7	11. ± 3.5

TABLE F-1

US EPA CROSS-CHECK PROGRAM 1984

Collection Date	Media	Nuclide	EPA-Results(A)	Teledyne Isotopes Results(B)
04/06	Water	I-131	6. ± 1.5	5.5 ± 0.4
04/13	Water	H-3	3508. ±728.	2660. ±342.
04/20	Water (Sample A)	Gross Alpha	35. ± 15.2	22. ± 4.6
		Ra-226	4.0 ± 1.04	5.4 ± 3.3
		Ra-228	8.3 ± 2.16	2.9 ± 0.6
		U	15. ± 10.4	13. ± 1.7
04/20	Water (Sample B)	Gross Beta	147. ± 12.7	117. ± 17.3
		Sr-89	23. ± 8.7	18. ± 7.5
		Sr-90	26. ± 2.6	22. ± 3.5
		Co-60	30. ± 8.7	29. ± 6.2
		Cs-134	30. ± 8.7	29. ± 4.6
		Cs-137	26. ± 8.7	29. ± 6.0
04/27	Urine	H-3	4496. ±645.	4168. ±173.
05/04	Water	Sr-89	25. ± 8.7	23. ± 5.
		Sr-90	5. ± 2.6	5.0 ± 0.5
05/18	Water	Gross Alpha	3. ± 8.7	2.7 ± 0.8
		Gross Beta	6. ± 8.7	6.9 ± 4.0
06/01	Water	Cr-51	66. ± 8.7	L.T. 90.
		Co-60	31. ± 8.7	33. ± 3.5
		Zn-65	63. ± 8.7	68. ± 15.
		Ru-106	29. ± 8.7	L.T. 50.
		Cs-134	47. ± 8.7	46. ± 5.
		Cs-137	37. ± 8.7	39. ± 1.7
06/08	Water	H-3	3051. ±622.	3210. ±834.
06/15	Water	Ra-226	3.5 ± 0.91	3.2 ± 0.4
		Ra-228	2.0 ± 0.52	4.2 ± 0.8

TABLE F-1

US EPA CROSS-CHECK PROGRAM 1984

Collection Date	Media	Nuclide	EPA-Results(A)	Teledyne Isotopes Results(B)
06/22	Milk	Sr-89	25. ± 8.7	22. ± 1.7
		Sr-90	17. ± 2.6	17. ± 4.6
		I-131	43. ± 10.4	40. ± 9.6
		Cs-137	35. ± 8.7	37. ± 3.
		K-40	1496. ±130.	1653. ± 46.
07/06	Urine	H-3	2319. ±700.	2400. ± 400.
07/13	Water	Pu-239	12.5 ± 2.1	14.3 ± 4.6
07/20	Water	Gross Alpha	6. ± 8.7	3.8 ± 2.4
		Gross Beta	13. ± 8.7	11.3 ± 3.5
07/27	Food (C)	Sr-89	25.0 ± 8.7	17. ± 9.
		Sr-90	20.0 ± 2.6	20. ± 9.
		I-131	39.0 ± 10.4	19. ± 3.5
		Cs-137	25.0 ± 8.7	26. ± 11.
		K-40	2605.0 ±226.0	3027. ±1183.
08/03	Water	I-131	34.0 ± 10.4	31. ± 3.0
08/10	Water	H-3	2817. ±617.	2930. ± 127.
08/17	Water	U	20.0 ± 10.4	21. ± 5.2
08/24	Air Filter	Gross Alpha	17. ± 8.7	16. ± 1.7
		Gross Beta	51. ± 8.7	47. ± 3.
		Sr-90	18. ± 2.4	13. ± 1.7
		Cs-137	15. ± 8.7	17. ± 4.6
09/07	Water	Sr-89	34. ± 8.7	29. ± 4.5
		Sr-90	19. ± 2.6	19. ± 1.0
09/14	Water	Ra-226	4.9 ± 1.27	3.8 ± 0.5
		Ra-228	2.3 ± 0.60	2.2 ± 0.4
09/21	Water	Gross Alpha	5.0 ± 8.7	6. ± 0.0
		Gross Beta	16.0 ± 8.7	14. ± 3.

TABLE F-1

US EPA CROSS-CHECK PROGRAM 1984

Collection Date	Media	Nuclide	EPA-Results(A)	Teledyne Isotopes Results(B)
10/05	Water	Cr-51	40. ± 8.7	L.T. 107.
		Co-60	20. ± 8.7	23. ± 10.4
		Zn-65	147. ± 8.7	155. ± 17.6
		Ru-106	47. ± 8.7	L.T. 53.
		Cs-134	31. ± 8.7	34. ± 12.
		Cs-137	24. ± 8.7	28. ± 10.
10/12	Water	H-3	2810. ±356.	2720. ± 531.
10/22	Water (Sample A)	Gross Alpha	14. ± 8.7	11. ± 1.7
		Ra-226	3.0 ± 0.80	3.5 ± 0.3
		Ra-228	2.1 ± 0.50	L.T. 1.
10/22	Water (Sample B)	Gr. Beta	64. ± 8.7	65. ± 10.
		Sr-89	11. ± 8.7	9. ± 3.5
		Sr-90	12. ± 2.6	13. ± 3.
		Co-60	14. ± 8.7	19. ± 3.5
		Cs-134	2. ± 8.7	L.T. 5.
		Cs-137	14. ± 8.7	17. ± 7.5
10/26	Milk	Sr-89	22. ± 8.7	15. ± 1.7
		Sr-90	16. ± 2.6	14. ± 3.
		I-131	42. ± 10.4	34. ± 9.6
		Cs-137	32. ± 8.7	32. ± 12.
		K-40	1517. ±131.	1370. ± 52.7
11/02	Urine	H-3	2012. ±599.	2033. ± 458.
11/16	Water	Gross Alpha	7.0 ± 8.7	7.3 ± 1.7
		Gross Beta	20.0 ± 8.7	21.7 ± 1.7
11/23	Air Filter	Gross Alpha	15. ± 8.7	15. ± 1.7
		Gross Beta	52. ± 8.7	54. ± 3.5
		Sr-90	21. ± 2.6	23. ± 3.
		Cs-137	10. ± 8.7	9. ± 4.6

TABLE F-1

US EPA CROSS-CHECK PROGRAM 1984

Collection Date	Media	Nuclide	EPA-Results(A)	Teledyne Isotopes Results(B)
12/07	Water	I-131	36. ± 10.4	36. ± 6.9
12/14	Water	H-3	3182. ±624.	3523. ±868.
12/21	Water	Ra-226	8.6 ± 2.2	9.3 ± 1.8
		Ra-228	4.1 ± 1.1	L.T. 1.3

Notes

(A) EPA Results-Expected laboratory precision (3 sigma). Units are pCi/ℓ for water, urine, and milk except K is in mg/l. Units are total pCi for air particulate filters.

(B) Teledyne Results - Average ± three sigma. Units are pCi/ℓ for water, urine, and milk except K is in mg/ℓ. Units are total pCi for air particulate filters.

(C) Units for food analysis are pCi/kg.

Quality Control Laboratory

Results

TABLE F-2

QUALITY CONTROL LABORATORY RESULTS

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	EPA Result ±3σ, n=3
STAF-326	Air Filter	August 1983	Gross beta	42±2	36±8.7
			Sr-90	14±2	10±2.6
			Cs-137	19±1	15±8.7
STW-328	Water	Sept. 1983	Gross alpha	2.3±0.6	5±8.7
			Gross beta	10.7±1.2	9±8..7
STW-329	Water	Sept. 1983	Ra-226	3.0±0.2	3.1±0.81
			Ra-228	3.2±0.7	2.0±0.52
STW-331	Water	Oct. 1983	H-3	1300±30	1210±570
STW-335	Water	Dec. 1983	I-131	19.6±1.9	20±10.4
STW-336	Water	Dec. 1983	H-3	2870±100	2389±608
STAF-337	Air Filter	Nov. 1983	Gross alpha	18.0±0.2	19±8.7
			Gross beta	58.6±1.2	50±8.7
			Sr-90	10.9±0.1	15±2.6
			Cs-137	30.1±2.5	20±8.7
STW-339	Water	Jan. 1984	Sr-89	47.2±1.9	36±8.7
			Sr-90	22.5±4.0	24±2.6
STW-343	Water	Feb. 1984	H-3	2487±76	2383±607
STM-347	Milk	March 1984	I-131	5.3±1.1	6±1.6
STW-349	Water	March 1984	Ra-226	4.0±0.2	4.1±1.06
			Ra-228	3.6±0.3	2.0±0.52
STW-350	Water	March 1984	Gross alpha	3.8±1.1	5±8.7
			Gross beta	24.2±2.0	20±8.7
STW-354	Water	April 1984	H-3	3560±50	3508±630
STW-355	Water	April 1984	Gross alpha	21.0±4.1	35±15.2
			Gross beta	127.8±4.1	147±12.7
			Sr-89	29.3±2.0	23±8.7
			Sr-90	16.6±0.7	26±2.6
			Ra-226	4.0±1.0	4.0±1.04
			Co-60	32.3±1.4	30±8.7
			Cs-134	33.6±3.1	30±8.7
			Cs-137	33.3±2.2	26±8.7

TABLE F-2

QUALITY CONTROL LABORATORY RESULTS

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	EPA Result ±3σ, n=3
STW-358	Water	May 1984	Gross alpha	3.0±0.6	3±8.7
			Gross beta	6.7±1.2	6±8.7
STM-366	Milk	June 1984	Sr-89	21±3.1	25±8.7
			Sr-90	13±2.0	17±2.6
			I-131	46±5.3	43±10.4
			Cs-137	38±4.0	35±8.7
			K-40	1577±172	1496±130
STW-368	Water	July 1984	Gross alpha	5.1±1.1	6±8.7
			Gross beta	11.9±2.4	13±8.7
STW-369	Water	August 1984	I-131	34.3±5.0	34.0±10.4
STW-370	Water	August 1984	H-3	3003±253	2817±617
STF-371	Food	July 1984	Sr-89	22.0±5.3	25.0±8.7
			Sr-90	14.7±3.1	20.0±2.6
			I-131	<172	39.0±10.4
			Cs-137	24.0±5.3	25.0±8.7
			K-40	2503±132	2605±226.0
STAF-372	Air Filter	August 1984	Gross alpha	15.3±1.2	17±8.7
			Gross beta	56.0±0.0	51±8.7
			Sr-90	14.3±1.2	18±2.4
			Cs-137	21.0±2.0	15±8.7
STW-375	Water	Sept. 1984	Ra-226	5.1±0.4	4.9±1.27
			Ra-228	2.2±0.1	2.3±0.60
STW-377	Water	Sept. 1984	Gross alpha	3.3±1.2	5.0±8.7
			Gross beta	12.7±2.3	16.0±8.7
STW-379	Water	Oct. 1984	H-3	2860±312	2810±356
STW-380	Water	Oct. 1984	Cr-51	<36	40±8.7
			Co-60	20.3±1.2	20±8.7
			Zn-65	150±8.1	147±8.7
			Ru-106	<30	47±8.7
			Cs-134	31.3±7.0	31±8.7
			Cs-137	26.7±1.2	24±8.7

TABLE F-2

QUALITY CONTROL LABORATORY RESULTS

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	EPA Result ±3σ, n=3
STM-382	Milk	Oct. 1984	Sr-89	15.7±4.2	22±8.7
			Sr-90	12.7±1.2	16±2.6
			I-131	41.7±3.1	42±10.4
			Cs-137	31.3±6.1	32±8.7
			K-40	1447±66	1517±131
STW-384	Water (Blind)	Oct. 1984 Sample A	Gross alpha	9.7±1.2	14±8.7
			Ra-226	3.3±0.2	3.0±0.8
			Ra-228	3.4±1.6	2.1±0.5
			Uranium	NA[e]	5±10.4
		Sample B	Gross beta	48.3±5.0	64±8.7
			Sr-89	10.7±4.6	11±8.7
			Sr-90	7.3±1.2	12±2.6
			Co-60	16.3±1.2	14±8.7
			Cs-134	<2	2±8.7
			Cs-137	16.7±1.2	14±8.7
STW-389	Water	Dec. 1984	H-3	3583±110	3182±624

[a] Results obtained by Teledyne Isotopes Midwest Laboratory as a participant in the environmental sample crosscheck program operated by the Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, (EPA), Las Vegas, Nevada.

[b] All results are in pCi/l, except for elemental potassium (K) data which are in mg/l, and air filter samples which are in pCi/filter.

[c] Unless otherwise indicated, the TIML results are given as the mean ±2 standard deviations for three determinations.

[d] USEPA results are presented as the known values ± control limits of 3σ for n=3.

[e] NA = Not analyzed.

[f] Analyzed but not reported to the EPA.

[g] Results after calculations corrected (error in calculations when reported to EPA).

APPENDIX G

1984 Annual Dairy Census

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
1.93km(1.20mi) N ①	5° A		-	-	-	13 Nannies 1 Billy	7	2 Sheep (Dorsetts) 4 Beef Cattle 7 Rabbits 5 Pigs	Sold Locally & Own Use	All year plus store bought feed
3.28km(2.04mi) N 2	3° A		Cows and goats are periodically kept here for quarantine from a few days to a few weeks. Animals are then shipped to foreign countries. If milked, milk may be sent to Reading Dairy or used for hogfeed if animals were recently treated with antibiotics.							25% of animals graze
7.90km(4.94mi) N 3	1° A		-	-	-	-	-	25 Pigs 6 Beef Cattle (Holstein)	Own Use and 1 or 2 Beef Cattle Sold Locally	Summer and during favorable Winter weather
8.53km(5.30mi) N 4	3° A		Holstein	80 Cows 55 Heifers	65	-	-	-	Hershey Foods & Own Use	April 15 to October

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
8.56km(5.32mi) N 5	357° A		-	-	-	-	-	38 Beef Cattle	Sold at Auction	April to October
16.9km(10.5mi) N ⑥	10° A		Holstein Guernsey	40 Cows 24 Heifers & Calves	35	-	-	-	Harrisburg Dairy & Own Use	March to November
5.05km(3.14mi) NNE 7	14° B		Holstein	190	110	-	-	-	Interstate Dairy & Own Use	Confined to silage and grains which were partially grown on farm
3.67km(2.28mi) NE 8	45° C		Holstein	18	13	-	-	-	Hershey Foods & Own Use	Mid-May to Mid-November

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
5.15km(3.20mi) NE 9	34° C		-	-	-	-	-	2 Beef Cattle	Own Use	May to November (if grass is available) Otherwise store bought hay and corn
6.58km(4.09mi) NE 10	35° C		Holstein	65 Cows 100 Heifers	65	-	-	-	Interstate Dairy & Own Use	Milk cows are barn fed. Heifers graze June to October
7.03km(4.37mi) NE 11	48° C		Holstein	270	120	-	-	-	Interstate Dairy & Own Use	Confined to their own silage
1.69km(1.05mi) ENE 12	65° D		Holstein	74 Cows 65 Heifers 17 Calves	69	-	-	2 Steers 1 Bull	Mt. Joy Co-op & Own Use	May 1 to November 1

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address *** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
2.01km(1.25mi) ENE 13	75^{o} D	**	-	-	-	-	-	7 Beef Cattle 2 Calves 4 Hogs 75 Chickens	Sold Privately & Own Use	All Summer
3.97km(2.47mi) ENE 14	68^{o} D		Holstein	21 Heifers 6 Calves	-	-	-	1 Bull	Sold at Auction	April 1 to October
4.18km(2.60mi) ENE 15	69^{o} D		-	-	-	-	-	1 Calf	Own Use	All year under favorable conditions
6.73km(4.18mi) ENE 16	59^{o} D		Holstein	59 Cows 74 Heifers and Calves	53	-	-	4 Chickens	Harrisburg Dairy & Own Use	May 1 to November 1

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
7.03km(4.37mi) ENE 17	75° D		Holstein	47	31	-	-	-	Interstate Dairy & Own Use	April to October
7.22km(4.49mi) ENE 18	57° D		Holstein	60 Cows 60 Heifers & Calves	60	-	-	-	Hershey Foods & Own Use	April to November
7.51km(4.67mi) ENE 19	71° D		Holstein	85 Cows 70 Heifers	78	-	-	-	Mt. Joy Co-op & Own Use	May to October
16.1km(10.0mi) ENE 20	68° D		-	-	-	87 Nannies 3 Billies	40	1 Steer	Processed and Distributed by Owner & Own Use	All year in the evenings under favorable conditions

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address *** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
1.77km(1.10mi) E 21	93° E		Holstein	200	120	-	-	-	Interstate Co-op & Own Use	April to November
3.22km(2.00mi) E 22	98° E		-	-	-	-	-	4 Beef Cattle	Own Use	April through Fall/ Winter on hay
5.58km(3.47mi) E 23	96° E		Holstein	54 Cows 50 Heifers	48	-	-	-	Hershey Foods	April to September
3.75km(2.33mi) ESE 24	104° F		Holstein	20 Cows 12 Heifers	20	-	-	-	Lehigh Valley Co-op	May to November

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
5.20km(3.23mi) FSE 25	104° F		Holstein	53 Cows 50 Heifers	50	-	-	65,000 Chickens	Hershey Foods	May to November
5.74km(3.57mi) ESE 26	117° F		Holstein	29 Cows 29 Heifers	29	-	-	1 Bull	Penn Daires	May to November (Not in the evenings)
6.11km(3.80mi) ESE 27	113° F		Holstein	64 Cows 30 Heifers	53	-	-	100 Steers	Hershey Foods Steers sold at Auction	May to October (Dairy Cows are on Silage)
6.89km(4.28mi) ESE 28	114° F		Holstein	4	4	-	-	45 Steers (Angus & Holstein) 50 Pigs	Sold Locally & Own Use	April to November

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address *** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
7.63km(4.74mi) ESE 29	121^{o} F		Holstein & Angus	24 Cows 12 Heifers	19	-	-	-	Mt. Joy Farmers Co-op	Confined to own feed
8.11km(5.04mi) ESE 30	115^{o} F		Holstein	37 Cows 30 Heifers	28	-	-	26,000 Chickens (Broilers)	Hershey Foods & Chickens Sold Commer-cially	April to October
8.11km(5.04mi) ESE 31	119^{o} F		Holstein	40 Cows 35 Heifers	35	-	-	-	Interstate Dairy	May to November
8.21km(5.10mi) ESE 32	113^{o} F		Holstein	26 Cows 14 Calves & Heifers	20	-	-	Approximately 50,000 Chickens	Interstate Dairy & Chickens and eggs sold Commercially	April to November (Dairy Cows are on feed)

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
8.25km(5.13mi) ESE 33	123° F		Holstein	130	95	-	-	150,000 Chickens	Interstate Dairy & Chickens Sold Commercially	Dairy Cows confined to own feed. Heifers graze May to October
8.53km(5.30mi) ESE 34	103° F		Ayrshire	126 Cows 138 Heifers	126	-	-	100 Steers 50 Beef Cattle (Cows & Calves) 400 Hogs	Harrisburg Daires and Processed and Used on Site	May to November
2.30km(1.43mi) SE 35	130° G		Holstein	40 Cows 25 Heifers	30	-	-	15 Steers	Hershey Foods & Steers sold at Auction	April to November
4.14km(2.57mi) SE 36	144° G		Jersey	3	0	1 Billy (Pet)	-	12 Chickens 1 Goose	Own Use	All year under favorable conditions

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
4.35km(2.70mi) SE 37	138° G		-	-	-	3 Nannies 1 Billy	0	-	-	-
6.03km(3.75mi) SE 38	141° G	**	-	-	-	-	-	65 Beef Cattle (Charlais & Angus) 450 Hogs	Sold to Markets	Own Silage
6.48km(4.03mi) SE 39	141° G		Holstein	40 Heifers	-	-	-	1 Bull	Hershey Foods	May to September
6.60km(4.10mi) SE 40	129° G		Holstein	150 Cows 150 Heifers	150	-	-	80 Steers 30 Chickens	Mt. Joy Farmers Co-op & Steers sold at Auction	May to October

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
7.43km(4.62mi) SE 41	136° G		-	-	-	-	-	2 Sheep	Own Use	May to October
7.59km(4.72mi) SE 42	126° G		-	-	-	-	-	33 Steer (Holstein)	-	Confined to own feed
7.88km(4.90mi) SE 43	131° G	**	-	-	-	8 Nannies 2 Billies	3	175 Beef Cattle (Holstein) 65,000 Chickens	Own Use Beef Cattle and eggs are sold commercially	During favorable conditions plus hay and grain year round
5.31km(3.30mi) S 44	180° J		-	-	-	1 Billy (Pet)	-	12 Beef Cattle	-	May to December

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
7.82km(4.86mi) SSW 45	200° K		Holstein	52 Cows 49 Heifers	40	-	-	-	Interstate Dairy	May to October
4.02km(2.50mi) SW 46	225° L	**	-	-	-	-	-	1 Bull 1 Heifer 5 Turkeys 25 Chickens	Own Use	Confined to store Bought Feed
4.26km(2.75mi) SW 47	226° L		-	-	-	-	-	24 Beef Cattle	Lancater Stock Yard	March to November
5.95km(3.70mi) SW 48	233° L	**	Holstein	1 Cow 6 Heifers	1	14 Nannies 1 Billy	1	1 Bull 6 Beef Cattle 2 Pigs	Own Use	All year plus grain and hay

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address *** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
6.03km(3.75mi) SW 49	225^{o} L		-	-	-	1 Nanny (Pet)	-	-	-	All Year
6.48km(4.03mi) WSW 50	242^{o} M		-	-	-	-	-	2 Steers (Holstein)	-	Confined to own feed
7.08km(4.40mi) WSW 51	238^{o} M		-	-	-	1 Nanny (Pet)	-	1 Hog	Own Use	All Year
7.66km(4.76mi) WSW 52	237^{o} M		Holstein	1 Heifer	-	3 Nannies 1 Billy	1 (Used for feed)	1 Steer (Holstein) 2 Hogs	Own Use	May to September (not in the evenings)

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
6.28km(3.90mi) W 53	270° N		-	-	-	-	-	4 Beef Cattle 3 Calves (Charlais)	Sold Locally & Own Use	All year plus feed from October to April
6.76km(4.20mi) W 54	262° N	**	Charlais	9 Cows 8 Calves	0	-	-	1 Bull 4 Steers	Sold Locally & Own Use	March to November
6.76km(4.20mi) W 55	262° N	**	Jersey	1 Cow 1 Calf	1	-	-	-	Own Use	March to November
4.96km(3.08mi) WNW 56	286° P		-	-	-	-	-	20 Beef Cattle	Sold to Auctions & Own Use	End of April to First Snow

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
5.20km(3.23mi) WNW 57	295° P		-	-	-	1 Billy 3 Nannies 4 Wethers	0	23 Steers	-	All Year
5.23km(3.25mi) WNW 58	286° P		-	-	-	1 Nanny	0	-	-	All Year excluding winter
5.63km(3.50mi) WNW 59	282° P		-	-	-	1 Nanny	0	-	Own Use	April to November
5.95km(3.70mi) WNW 60	295° P		Holstein Jersey	72 Cows	36	3 Billies 8 Nannies	0	7 Beef Cattle	Interstate Milk Co-op	May to October

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address*** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
6.36km(3.95mi) WNW 61	300° P		-	-	-	-	-	2 Beef Cattle	Own Use	Confined to grain
6.81km(4.23mi) WNW 62	290° P		-	-	-	1 Nanny	1	30 Ducks 20 Chickens	Own Use	All Year
7.08km(4.40mi) WNW 63	293° P		-	-	-	2 Nannies	0	-	-	March to November
7.08km(4.40mi) WNW 64	297° P		-	-	-	1 Nanny	0	-	-	April to November

1984 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	Name, Address *** & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
10.8km(6.70mi) WNW (65)	293° P		Holstein	105	45	-	-	-	Rutters Dairy	April to September
TOTALS			Holstein Jersey Ayrshire Guernsey Charlais Angus	2,228 Cows 1,132 Heifers &Calves	1,649	15 Billies 147 Nannies 4 Wethers	54	836 Beef Cattle (Includes Steers, Cows, Heifers, and Calves) 934 Pigs & Hogs 4 Sheep 356,166 Chickens 7 Rabbits 7 Bulls 5 Turkeys 1 Goose 30 Ducks	Various	Various

*Includes livestock which are used only for human consumption and all dairy farms within five miles of TMINS plus regularly sampled milk farms.

**Indicates new farm this census.

#In lower right-hand corner of the first column indicates running total of farms surveyed. circled #'s indicate regularly sampled milk farms.

***Names and addresses available from Three Mile Island Environmenta Controls.

APPENDIX H

1984 Annual Garden Census

1984 ANNUAL GARDEN CENSUS *

Meteorological Sector Designation	Distance and Direction	Azimuth	Name, Address** and Telephone Number	Type of Vegetation	How Used and Distribution of Consumers
A (1)	1.80 km (1.10 mi.) N	4°		Assorted	Own use 4 Adults 3 Children
B (2)	1.40 km (0.90 mi.) NNE	31°		Assorted	Own use 2 Adults 1 Teenager 1 Child
C (3)	1.00 km (0.60 mi.) NE	56°		Assorted	Own use 2 Adults 1 Teenager 1 Child
D (4)	0.80 km (0.50 mi.) ENE	59°		Assorted	Own use 3 Adults Sold Locally
E (5)	1.00 km (0.60 mi.) E	89°		Assorted	Own use 2 Adults
F (6)	0.80 km (0.50 mi.) ESE	112.5°		Assorted	Own use 3 Adults Also sold commercially at stand along Rt. 441 S.

1984 ANNUAL GARDEN CENSUS *

Meteorological Sector Designation	Distance and Direction	Azimuth	Name, Address** and Telephone Number	Type of Vegetation	How Used and Distribution of Consumers
G (7)	0.90 km (0.60 mi.) SE	135°		Assorted	Own use 3 Adults Also sold commercially at stand along Rt. 441
H (8)	1.10 km (0.70 mi.) SSE	152°		Assorted	Own use 3 Adults
J (9)	4.00 km (2.40 mi.) S	190°		Assorted	Own use 4 Adults 1 Teenager 1 Child
K (10)	1.25 km (0.75 mi.) SSW Lot #114 Shelley Is.	220°		Assorted	Own use 2 Adults
L (11)	3.00 km (1.90 mi.) SW	236°		Assorted	Own use 2 Adults
M (12)	2.20 km (1.30 mi.) WSW	253°		Assorted	Own use 4 Adults

1984 ANNUAL GARDEN CENSUS *

Meteorological Sector Designation	Distance and Direction	Azimuth	Name, Address** and Telephone Number	Type of Vegetation	How Used and Distribution of Consumers
N (13)	2.20 km (1.30 mi.) W	270°		Assorted	Own use 3 Adults
P (14)	3.80 km (2.40 mi.) WNW	298°		Assorted	Own use 3 Adults
Q (15)	1.84 km (1.20 mi.) NW (Hill Island)	320°		Assorted	Own use 2 Adults
R (16)	2.10 km (1.30 mi.) NNW (Hill Island)	335°		Assorted	Own use 3 Adults 1 Teenager

* - Census identifies nearest garden (greater than 50 m^2) in each 16 meteorological sectors.

** - Names and addresses available from Three Mile Island - Environmental Controls Department.

APPENDIX I

Assessment of Radiological Effluent Data for 1984

TMINS Effluents

Neither TMI-1 nor TMI-2 have been operational since 1979, therefore, no additional fission or activation products have been generated since that time. Most of the short-lived radionuclides have decayed and are no longer present in detectable concentrations in the effluent releases.

Liquid Effluents

TMI-1 processes liquid wastes generated on the primary side through the waste evaporators. Most of the radioactivity is removed from this liquid prior to discharge. This processed primary water represents the largest percentage of liquid releases. A very small percentage was also released from the secondary side due to primary-to-secondary leakage in the Once Through Steam Generators (OTSG). TMI-2 generated large volumes of highly contaminated water during the accident. The water was processed through demineralizer systems to remove the contamination and is stored onsite in large tanks. To date, none of this water has been discharged. Currently the only liquid releases from TMI-2 are those from such areas as Waste Storage sumps, Air Intake Tunnel sump, Turbine Building sump, etc. Tritium was the most abundant radionuclide in the liquid effluents from TMI-1, while for the TMI-2 liquid effluents, it was Sr-90. Tables I-1 and I-2 present the liquid effluents released during 1984 for TMI-1 and TMI-2, respectively.

Gaseous Effluents

The noble gas inventory in TMI-1 either has been removed using the gaseous radwaste treatment system or has decayed. Krypton-85 released from TMI-1 during 1984 resulted from residual gas left over from the 1983 injection of

Kr-85 into the primary coolant as a tracer to study the OTSG repair and primary-to-secondary leakage.

The only detectable noble gas remaining in TMI-2 is Kr-85 which can be found in various locations such as the core, equipment, water inside the Reactor Building, etc. For both TMI-1 and TMI-2, Kr-85 was the most abundant radionuclide in gaseous effluents. Tables I-1 and I-2 present the gaseous effluents released during 1984 for TMI-1 and TMI-2, respectively.

Dose Analysis

Effluent data obtained from TMI-1 and TMI-2 (Table I-1 and I-2, respectively) were used to calculate the postulated dose to an individual and the population within 50 miles of the plant. Doses were calculated, utilizing the guidelines and methodology set forth in USNRC Regulatory Guide 1.109 (27).

The dose summary tables (Table I-3 and Table I-4) present the maximum hypothetical doses to an individual resulting from the release of liquid and gaseous effluents from TMI-1 and TMI-2 during the 1984 reporting period. Population doses for the respective units are presented in Table I-5.

1. Liquid (Individual)

The first two lines of Table I-3 and Table I-4 present the maximum hypothetical dose to an individual. Presented are the total body and critical organ doses due to the radionuclides in the liquid effluents. As recommended in USNRC Regulatory Guide 1.109, calculations are performed on the four age groups and eight organs. The pathways considered are water ingestion, shore exposure, and fresh water sportfish ingestion. The latter two pathways are considered to be the primary recreational activities associated with the Susquehanna River in the vicinity of TMINS. The "receptor" would be that individual who consumes water from the Susquehanna River, eats fish that reside in the plant discharge, and stands on the shoreline influenced by the plant discharge.

The tables present the maximum total body dose and critical organ dose for the age group most effected.

For the 1984 reporting period, the calculated maximum hypothetical total body dose received by anyone would have been 0.375 mrem (TMI-1) and 0.00677 mrem (TMI-2) to an adult. These represent 12 percent and 0.23 percent, respectively, of the USNRC permissible yearly dose limits. Similarly, the maximum hypothetical organ dose would have been 0.56 mrem to the liver of a teenager (TMI-1) and 0.0141 mrem to the bone of a teenager (TMI-2). These represent 5.6 percent and 0.14 percent, respectively, of the USNRC permissible yearly dose limits.

2. Gaseous (Individual)

There are seven major pathways considered in the dose calculation for gaseous effluents. These are: (1) plume exposure, (2) inhalation, consumption of (3) cow milk, (4) goat milk, (5) vegetables, (6) meat, and (7) standing on contaminated ground.

Lines 3 and 4 of Table I-3 and Table I-4 present the maximum plume exposure generally at, or near, the site boundary. The notation of "air dose" is interpreted to mean that these doses are not to an individual, but are considered to be the maximum dose at a location. The location is not necessarily a receptor. The tables present the distance in meters and the affected sector (compass point). It should be noted that real-time meteorology was used in all dose calculations for gaseous effluents.

With respect to the releases for the 1984 reporting period, the maximum plume exposure (air dose) would have been 0.000000186 and 0.0000211 mrad (TMI-1) and 0.000224 and 0.0254 mrad (TMI-2) gamma and beta dose, respectively. All of these represent equal to or less than 0.13 percent of the USNRC permissible yearly dose limits.

Lines 5 and 6 present the calculated dose to the closest receptor (individual) in the maximally affected sector(s). The location of the receptor is described by both distance (meters) and direction from the site.

Plume exposures to an individual, regardless of age, from gaseous effluents during the 1984 reporting period were 0.000000161 mrem and 0.0000194 mrem (TMI-1) and 0.0000933 mrem and 0.0112 mrem (TMI-2) total body and skin exposure, respectively. All of these represent equal to or less than 0.075 percent of the USNRC permissible yearly dose limits.

Line 7 represents the maximum exposed organ due to radioactive iodine and particulates. This does not include the whole body plume exposure which was separated out on line 5. The doses presented in this section again reflect the maximum exposed organ for the appropriate age group.

During 1984, gaseous iodines and particulates from TMI-1 would have resulted in a maximum dose of 0.000000243 mrem to the bone of a child residing 2,500 meters from the site in the WNW sector. The corresponding dose from TMI-2 was 0.0018 mrem to the total body of a child residing 750 meters from the site in the SE sector. No other organ of any age group would have received a dose greater than this from either TMI-1 or TMI-2. All of thse doses represent equal to or less than 0.012 percent of the USNRC permissible yearly dose limits.

3. Liquid and Gaseous (Population)

Lines 8-11 (Table I-5) present the person-rem dose resulting from the liquid and gaseous effluents. These doses are summed over all pathways and the affected population. Liquid person-rem is based upon the population encompassed within the region from the TMINS outfall extending down to the Chesapeake Bay. The population dose due to gaseous effluents is based upon the 1980 population projections of the Final Safety Analysis Report (FSAR) and considers the population out to a distance of 50 miles around TMINS. Population doses are summed over all distances and sectors to give an aggregate dose.

Based upon the calculations performed for the 1984 reporting period, TMI-1 and TMI-2 liquid and gaseous effluents resulted in total body and maximum critical organ population doses of less than 1.0 person-rem.

TABLE I-1

1984 TMI-1 EFFLUENT RELEASES BY RADIONUCLIDE

LIQUID

Radionuclide		Total Release (Ci)
Sr-90		0.00163
Cs-134		0.00246
Cs-137		0.02170
Co-60		0.00275
Fe-55		0.00518
Sb-125		0.00030
	Total	0.03403
H-3		1.72

GASEOUS

Radionuclide		Total Release (Ci)
Kr-85		0.36300000000
Sr-90		0.00000000127
	Total	0.36300000127
H-3		0.0000503

TABLE I-2

1984 TMI-2 EFFLUENT RELEASES BY RADIONUCLIDE

LIQUID

Radionuclide		Total Release (Ci)
Sr-90		0.00036175
Cs-134		0.00000698
Cs-137		0.00027683
Tc-99m*		0.00267000
	Total	0.00331556
H-3		0.00015643

* Medical Administration

GASEOUS

Radionuclide		Total Release (Ci)
Kr-85		246.4700000000
Sr-90		0.0000001640
Cs-134		0.0000000137
Cs-137		0.0000045480
	Total	246.4700047257
H-3		14.30000000
Gr-α		0.00000043

TABLE I-3

SUMMARY OF MAXIMUM INDIVIDUAL DOSES FROM

TMI-1 EFFLUENTS

1984

Liquid 01/01/84 through 12/31/84
Gaseous 01/01/84 through 12/31/84
Air 01/01/84 through 12/31/84

	Effluent	Applicable Organ	Estimated Dose/year (mrem)	Age Group	Location Dist (M)	Location Dir (Toward)	Percnt of Applicable Limit	NRC Limit (mrem/yr)
1.	Liquid	Total Body	3.75E-1	Adult	Receptor 1		12.0	3.0
2.	Liquid	Liver	5.60E-1	Teen	Receptor 1		5.6	10.0
3.	Noble Gas	Air Dose (Gamma-mrad)	1.86E-7	- - -	2413	W	1.9E-6	10.0
4.	Noble Gas	Air Dose (Beta-mrad)	2.11E-5	- - -	2413	W	1.1E-4	20.0
5.	Noble Gas	Total Body	1.61E-7	All	2500	W	3.2E-6	5.0
6.	Noble Gas	Skin	1.94E-5	All	2500	W	1.3E-4	15.0
7.	Iodine and Particulate	Bone	2.43E-7	Child	2500	WNW	1.6E-6	15.0

TABLE I-4

SUMMARY OF MAXIMUM INDIVIDUAL DOSES FROM

TMI-2 EFFLUENTS

1984

Liquid 01/01/84 through 12/31/84
Gaseous 01/01/84 through 12/31/84
Air 01/01/84 through 12/31/84

	Effluent	Applicable Organ	Estimated Dose/year (mrem)	Age Group	Location Dist (M)	Location Dir (Toward)	Percnt of Applicable Limit	NRC Limit (mrem/yr)
1.	Liquid	Total Body	6.77E-3	Adult	Receptor 1		.23	3.0
2.	Liquid	Bone	1.41E-2	Adult	Receptor 1		.14	10.0
3.	Noble Gas	Air Dose (Gamma-mrad)	2.24E-4	- - -	454	SE	.0022	10.0
4.	Noble Gas	Air Dose (Beta-mrad)	2.54E-2	- - -	454	SE	.13	20.0
5.	Noble Gas	Total Body	9.33E-5	All	750	SE	.0019	5.0
6.	Noble Gas	Skin	1.12E-2	All	750	SE	.075	15.0
7.	Iodine and Particulates	Total Body	1.80E-3	Child	750	SE	.012	15.0

TABLE I-5

SUMMARY OF POPULATION DOSES FROM

TMI-1 EFFLUENTS FOR

1984

Liquid 01/01/84 through 12/31/84
Gaseous 01/01/84 through 12/31/84

	Effluent	Applicable Organ	Estimated Population Dose (Person-rem)
8.	Liquid	Total Body	.25
9.	Liquid	Bone	.80
10.	Gaseous	Total Body	.0000035
11.	Gaseous	Skin	.00036

SUMMARY OF POPULATION DOSES FROM

TMI-2 EFFLUENTS FOR

1984

Liquid 01/01/84 through 12/31/84
Gaseous 01/01/84 through 12/31/84

	Effluent	Applicable Organ	Estimated Population Dose (Person-rem)
8.	Liquid	Total Body	.036
9.	Liquid	Bone	.14
10.	Gaseous	Total Body	.083
11.	Gaseous	Skin	.23

APPENDIX J

1984

Groundwater Monitoring Report

Introduction

Geology

Three Mile Island Nuclear Station is located in the Triassic lowland of Pennsylvania, a region often referred to as the Gettysburg Basin. The island was formed as a result of fluvial deposition by the Susquehanna River and is composed of sub-rounded to rounded sand and gravel, containing varying amounts of silt and clay. Soil depths vary from approximately six feet at the south end of the island to about 30 feet at the center of the island. The site is underlain by Gettysburg shale which lies at approximately 277 feet elevation.

There are two different water bearing zones in the naturally deposited materials of TMINS: one zone in the overburden material of the island and the other in the underlying Gettysburg shale. For the most part, the natural island overburden material has a low permeability while the water-bearing characteristics of the Gettysburg shale may vary from significant transport to virtually none.

History of Groundwater Monitoring Program at TMINS

In January 1980, the development of eight stations to monitor groundwater quality began at TMINS. Five of the monitoring stations were located around the TMI-2 containment structure with two additional stations placed outside the TMI-2 secured area fence. An eighth station was located at the north end of the island to serve as a control.

During the development of each monitoring station, groundwater samples were obtained for tritium and gamma isotopic analyses. With the complete installation of the eight monitoring stations in April 1980, groundwater sampling on a weekly basis was initiated.

In addition to the monitoring stations, seven observation stations were drilled during the end of April and the beginning of May 1980. Six of the observation stations were located inside the TMI-2 secured area while a seventh is positioned at the south end of the island.

During the first week of May 1980, the groundwater monitoring program was expanded to include the observation stations as sampling locations. Water level measurements of the groundwater stations were also included in the program. Refer to Figure J-1 for the location of monitoring and observation stations. The 15 stations were sampled on a weekly basis from May 2, 1980, to June 24, 1981. (A surface water sample from the East Dike Catch Basin (EDCB) was incorporated into the groundwater monitoring program during January 1981.) Starting on July 1, 1981, and continuing through February 1982, the sampling was performed monthly. From March 1982 through July 1983, MS-1, MS-2, MS-3, OS-10, OS-16, and OS-17 were sampled weekly while the remaining stations followed the monthly schedule. Beginning in August 1983 and continuing until the present time, all of the stations were sampled on a monthly basis.

During the course of 1981, the procedure for groundwater sampling was changed. Prior to June 3, 1981, the eight monitoring stations were pumped for several minutes and then sampled. At the end of May 1981 the pumps were removed from the monitoring stations. From June 3, 1981 onward, the monitoring stations were sampled by bailing. The observation stations have been sampled by the bailing method since their installation.

Results

During the 1984 monitoring period, elevated tritium concentrations were seen in samples obtained from stations located within and adjacent to the TMI-2 secured-area fence. Stations MS-2, MS-3, OS-10, OS-16, and OS-17 which are located near the TMI-2 Borated Water Storage Tank (BWST) showed tritium concentrations ranging from 740 pCi/L to 26,000 pCi/L. Refer to Table J-1 for the 1984 tritium results.

The remaining stations located in the vicinity of the TMI-2 secured-area fence also showed some tritium results which were slightly above normal background concentrations (150 pCi/L to 300 pCi/L). Concentrations in samples from MS-4, MS-5, MS-6, MS-7, MS-8, OS-13B, and OS-14 ranged from 160 pCi/L to 1,300 pCi/L. Tritium concentrations reported in MS-1, OS-15 and the EDCB samples were background. (Both MS-1 and OS-15 are considered control stations due to their locations away from the plant at the north and south ends of TMINS, respectively.) Tritium concentrations in the EDCB ranged from <82 pCi/L to 290 pCi/L.

Tritium concentrations in all the ground water samples were below the limits established in 10 CFR 20, Appendix B for water in unrestricted areas (3,000,000 pCi/L).

The elevated tritium concentrations detected in the stations located within and adjacent to the TMI-2 secured-area fence were due primarily to past spills from the TMI-2 BWST. In January 1982, approximately 3,000 gallons of BWST water spilled onto the ground when an outside feed pipe cracked. Also, in late August and early September 1983, approximately 250 gallons of BWST water leaked onto the ground. Since September 1983, no additional spills or leaks from the TMI-2 BWST have occurred. Consequently, tritium concentrations in samples from stations near the TMI-2 BWST generally trended downward during 1984. Occasionally, small fluctuations in tritium concentrations were noted in response to precipitation events.

During 1984, MS-4, MS-6, MS-7, MS-8, OS-13B and OS-14 which are located a distance away from the BWST, occasionally showed above background tritium concentrations due to past BWST leaks, surface water runoff from a contaminated equipment hatch on the west side of the TMI-2 Containment Building, and water transfers into the TMI-2 Condensate Water Storage Tanks located on the south side of the Turbine Building.

Gamma Analysis

During 1984, the naturally occurring radionuclides K-40, Ra-226, and Th-228 occasionally were detected in the groundwater samples. Cesium-137 (a fission product) was detected in two samples during the year. The October 8, 1984, samples from MS-2 and OS-17 showed Cs-137 concentrations of 2.34 $\pm$ 1.07 pCi/L and 2.18 $\pm$ 1.2 pCi/L, respectively. Both Cs-137 concentrations were very low and can be attributed to past BWST spills. The detection of Cs-137 in MS-2 and OS-17 was due to the presence of sediment in the samples. As noted in past years, boildown analyses performed on MS-2 samples have confirmed the presence of Cs-137 in the sediment. Since Cs-137 has an affinity for sediments and the groundwater sampling procedure (bailing of the station) tends to dredge up sediments, the detection of Cs-137 is likely in samples heavily laden with sediment like MS-2 and OS-17.

Strontium-89 and Strontium-90

During 1984 no Sr-89 or Sr-90 was detected in any of the quarterly composite groundwater samples.

Gross Alpha

During 1984 gross alpha results of the quarterly composite samples showed concentrations ranging from LLD (<.7) to 90 pCi/L. Samples obtained from MS-2, OS-10, OS-13B, OS-14, OS-16 and OS-17 were laden with sediment and have the highest gross alpha concentrations. Gross alpha activity in the samples was attributed to the presence of naturally occurring Ra-226 and Th-228, both alpha emitters. Table J-2 presents gross alpha results by station for 1984.

Deviations from the Groundwater Monitoring Program During 1984

No samples were collected from OS-9 during 1984 due to blockage in the station. Only two samples were collected from OS-15 during 1984 due to blockage in the station. Also, monthly samples were not collected from OS-10 during February, October, and November due to low water table conditions.

Conclusions

Since the groundwater monitoring program began in 1980, tritium is the only radionuclide consistently detected in certain sampling stations. Past leaks of the TMI-2 BWST are responsible for the eleveated tritium concentrations detected in the stations located within the TMI-2 secured-area fence. In 1982, a catch basin was installed beneath the TMI-2 BWST to prevent leakage from reaching the groundwater reserve beneath the tank. Also, a protective housing was constructed above the BWST's valves and fittings to prevent weathering effects. At the same time, a computerized level indicator was installed to provide a more accurate method of measuring the BWST water level. During 1984, maintenance was performed on valves and fittings inside the BWST instrument cabinet which was the source of the August/September 1983 leakage. Also, a collection tray was installed under the instrument cabinet as an added precaution to contain leakage.

Based on hydrogeologic data for the TMINS site, groundwater stored within TMINS poses no contamination threat to any domestic wells across the river. As a result, no adverse effects on the groundwater quality outside of TMINS will be evidenced. The natural hydrologic cycle, combined with long groundwater transport times, will prevent any groundwater contamination from TMINS from adversely affecting the Susquehanna River.

TABLE J-1

1984 TRITIUM CONCENTRATIONS IN TMI

GROUNDWATER

(pCi/L ± 2σ)

Date of Sample	MS-1	MS-2	MS-3	MS-4	MS-5	MS-6	MS-7	MS-8
January 9, 1984	120± 70	5870± 700	840± 130	650±120	270± 80	350± 90	460±100	550±110
February 6, 1984	100± 70	5290± 580	1740± 450	990±130	280± 80	340± 90	520±110	470± 80
March 6, 1984	70± 30	4020± 560	810± 40	600± 50	250± 40	300± 40	510± 70	530± 80
April 2, 1984	50± 49	2760± 190	1640± 130	680± 80	330± 60	270± 50	410± 60	370± 50
May 1, 1984	80± 51	3520± 230	740± 70	810± 70	160± 40	190± 70	400± 80	400± 50
June 4, 1984	140± 40	2000± 100	1900± 100	1200±100	350± 40	560± 40	500± 40	480± 50
July 2, 1984	170± 30	4000± 100	1400± 100	1300±100	190± 40	380± 50	400± 50	410± 60
August 6, 1984	150± 40	4500± 100	2000± 100	970± 50	260± 40	340± 40	340± 30	450± 40
September 4, 1984	160± 40	3600± 100	1500± 100	1000±100	270± 40	280± 40	390± 50	410± 50
October 8, 1984	130± 40	4600± 100	1900± 100	940± 50	210± 40	290± 40	520± 40	410± 50
November 5, 1984	100± 40	2600± 100	1600± 100	560± 40	210± 40	230± 40	370± 40	260± 40
December 3, 1984	150± 40	1600± 100	1300± 100	440± 40	150± 30	160± 30	280± 40	280± 40

TABLE J-1 (Continued)

1984 TRITIUM CONCENTRATIONS IN TMI

GROUNDWATER

(pCi/L ± 2σ)

Date of Sample	OS-9	OS-10	OS-13B	OS-14	OS-15	OS-16	OS-17	EDCB
January 9, 1984	--- ---	6260± 750	790±120	500±100	--- ---	12800±1500	26000±3100	120± 70
February 6, 1984	--- ---	--- ---	680±120	570±110	--- ---	--- ---	15500±1200	260± 80
March 6, 1984	--- ---	5760± 360	610± 50	540± 50	--- ---	8240± 740	19300±1200	150± 30
April 2, 1984	--- ---	5240± 330	500± 60	550± 70	70± 39	8700± 780	7250± 700	190± 40
May 1, 1984	--- ---	3870± 250	550± 60	460± 60	70± 42	8330± 870	6490± 790	220± 50
June 4, 1984	--- ---	3500± 100	630± 50	620±110	--- ---	6000± 100	16000±1000	230± 30
July 2, 1984	--- ---	2200± 100	590± 50	410± 40	--- ---	6200± 100	7300± 600	170± 40
August 6, 1984	--- ---	2400± 100	620± 40	530± 40	--- ---	8000± 100	14000±1000	290± 40
September 4, 1984	--- ---	1200± 100	840± 50	550± 90	--- ---	12000±1000	8000± 600	120± 40
October 8, 1984	--- ---	--- ---	920± 70	640± 50	--- ---	14000±1000	7700± 600	210± 40
November 5, 1984	--- ---	--- ---	610± 50	390± 40	--- ---	14000±1000	8000± 600	82± 41
December 3, 1984	--- ---	1600± 100	519± 50	470± 50	--- ---	7600± 600	4800± 500	140± 50

TABLE J-2

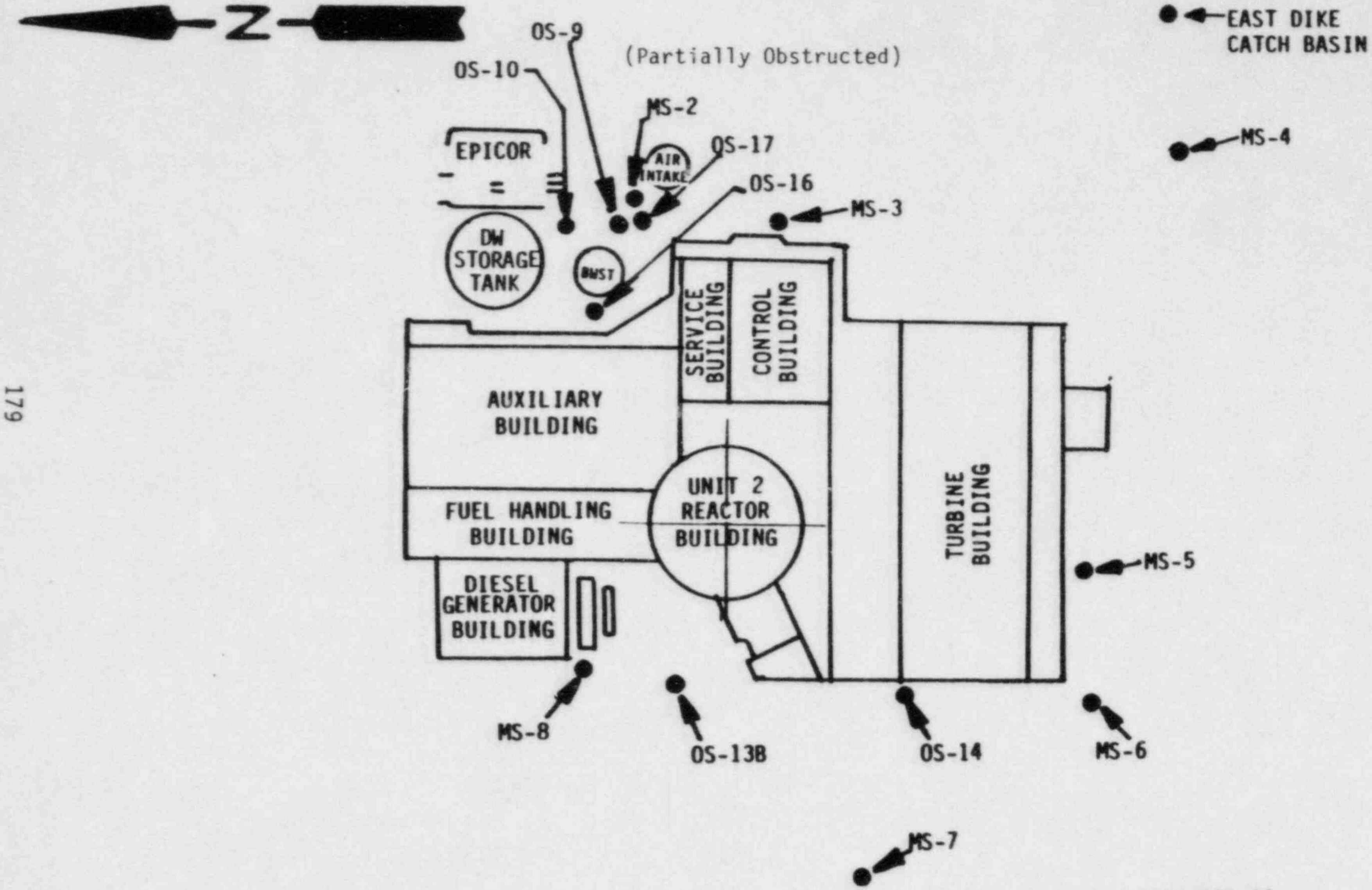
1984 GROSS ALPHA RESULTS

(pCi/L ± 2σ)

Station No.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
1	14 ± 6	16 ± 6	21 ± 9	12 ± 6
2	35 ± 12	47 ± 23	74 ± 26	52 ± 27
3	<6	<5	16 ± 7	29 ± 18
4	14 ± 5	30 ± 8	26 ± 10	22 ± 8
5	<3	<3	8.3 ± 5.0	11 ± 5
6	<5	5.0 ± 1.7	12 ± 6	14 ± 8
7	8.9 ± 4.3	9.7 ± 4.8	19 ± 7	17 ± 8
8	4.8 ± 3.4	10 ± 5	14 ± 7	20 ± 7
9	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE
10	22 ± 14	46 ± 21	26 ± 12	13 ± 9
13B	24 ± 18	38 ± 17	85 ± 29	27 ± 13
14	22 ± 11	37 ± 22	70 ± 27	52 ± 20
15	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE
16	59 ± 27	21 ± 12	40 ± 18	52 ± 18
17	28 ± 14	23 ± 12	90 ± 31	69 ± 36
EDCB	<.7	1.8 ± 1.2	<2	1.8 ± 1.2

FIGURE J-1

LOCATION OF MONITORING AND OBSERVATION STATIONS



Comments: (1) MS-1 located in north parking lot @ coordinates N301,460.04 E2,286,538.94

(2) OS-15 located on south end of island @ coordinates N292,985.44 E2,287,765.09

FIGURE J-2

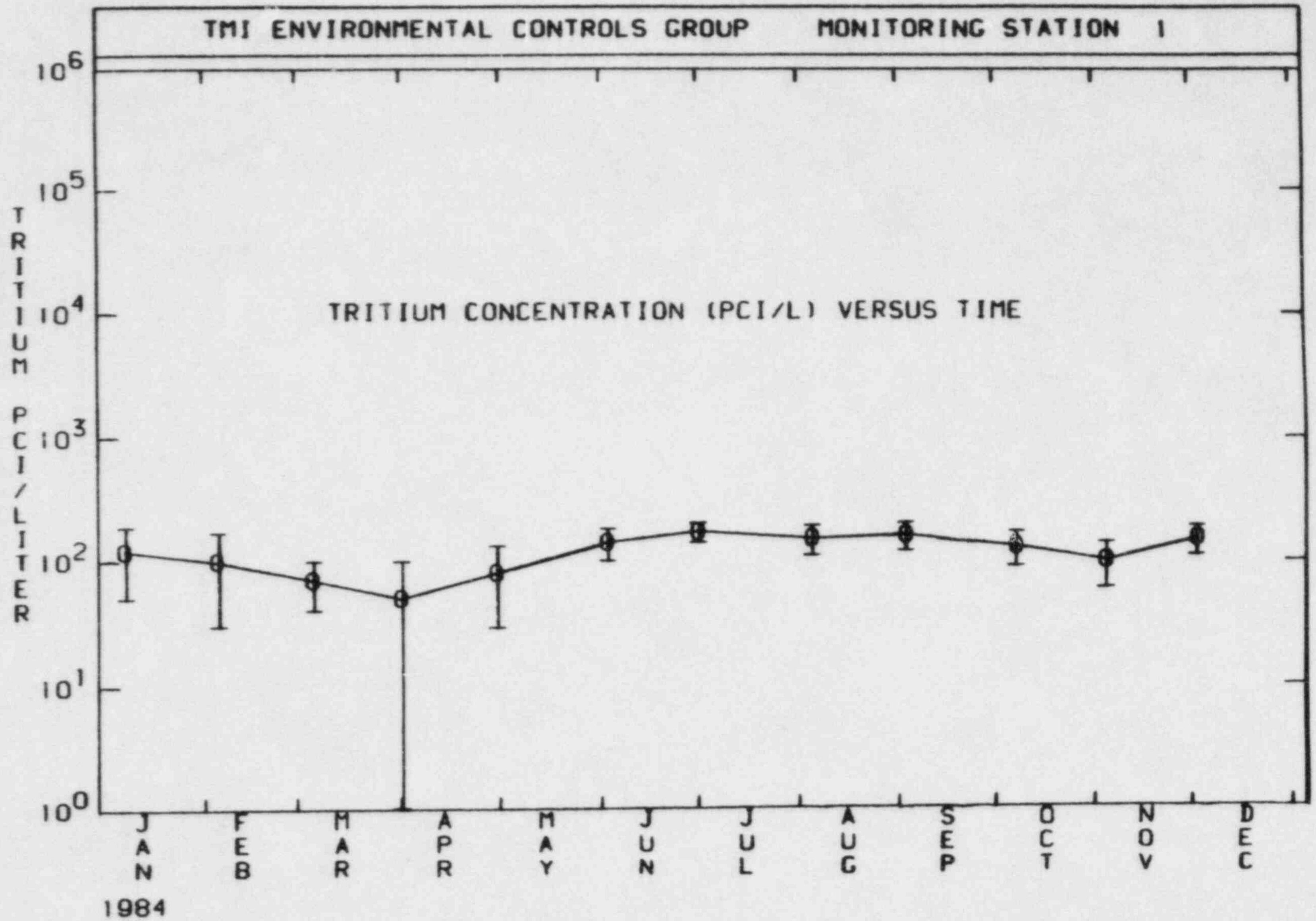

TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 1
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1984

FIGURE J-3

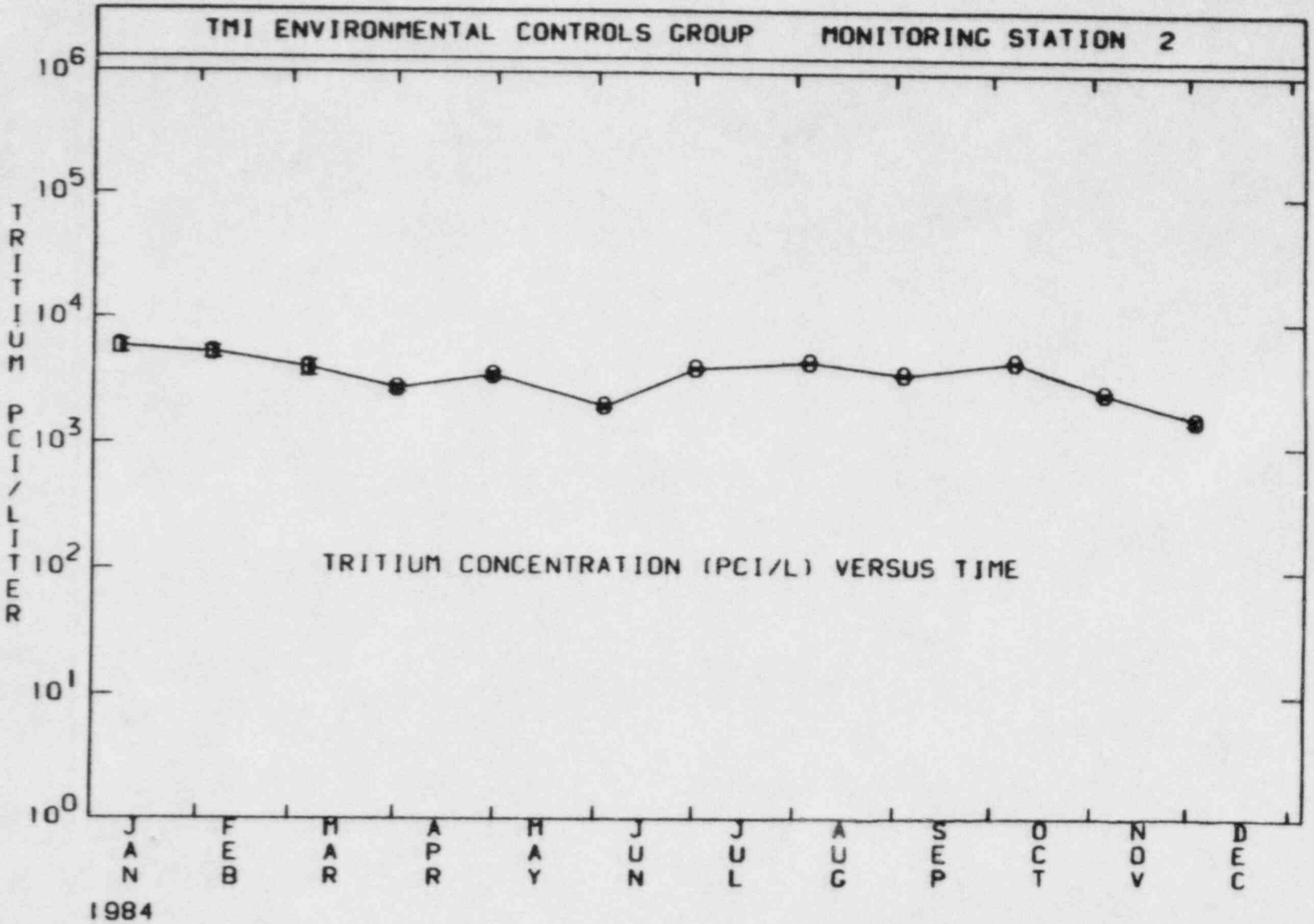

TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 2
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

FIGURE J-4

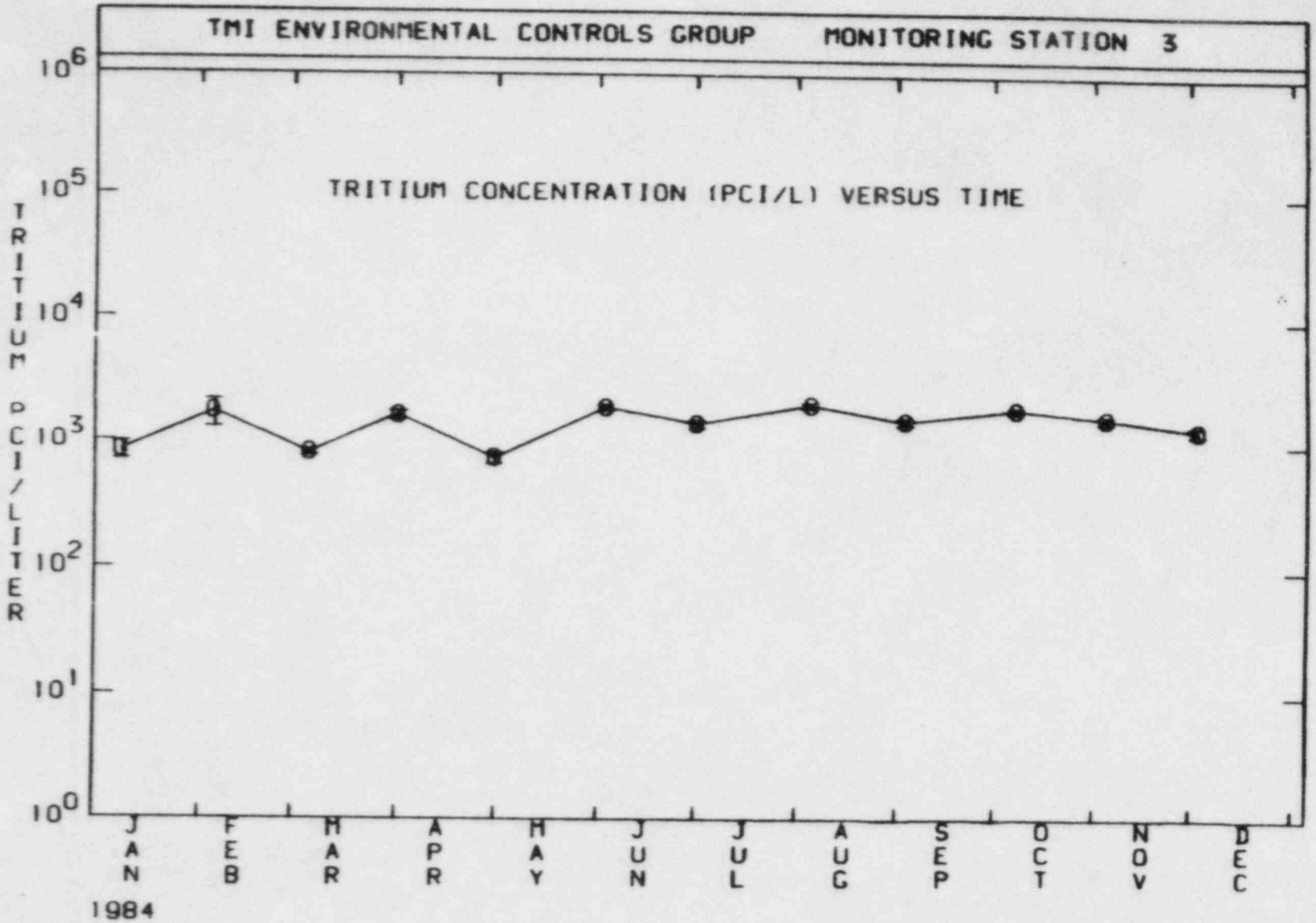

TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 3
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1984

FIGURE J-5

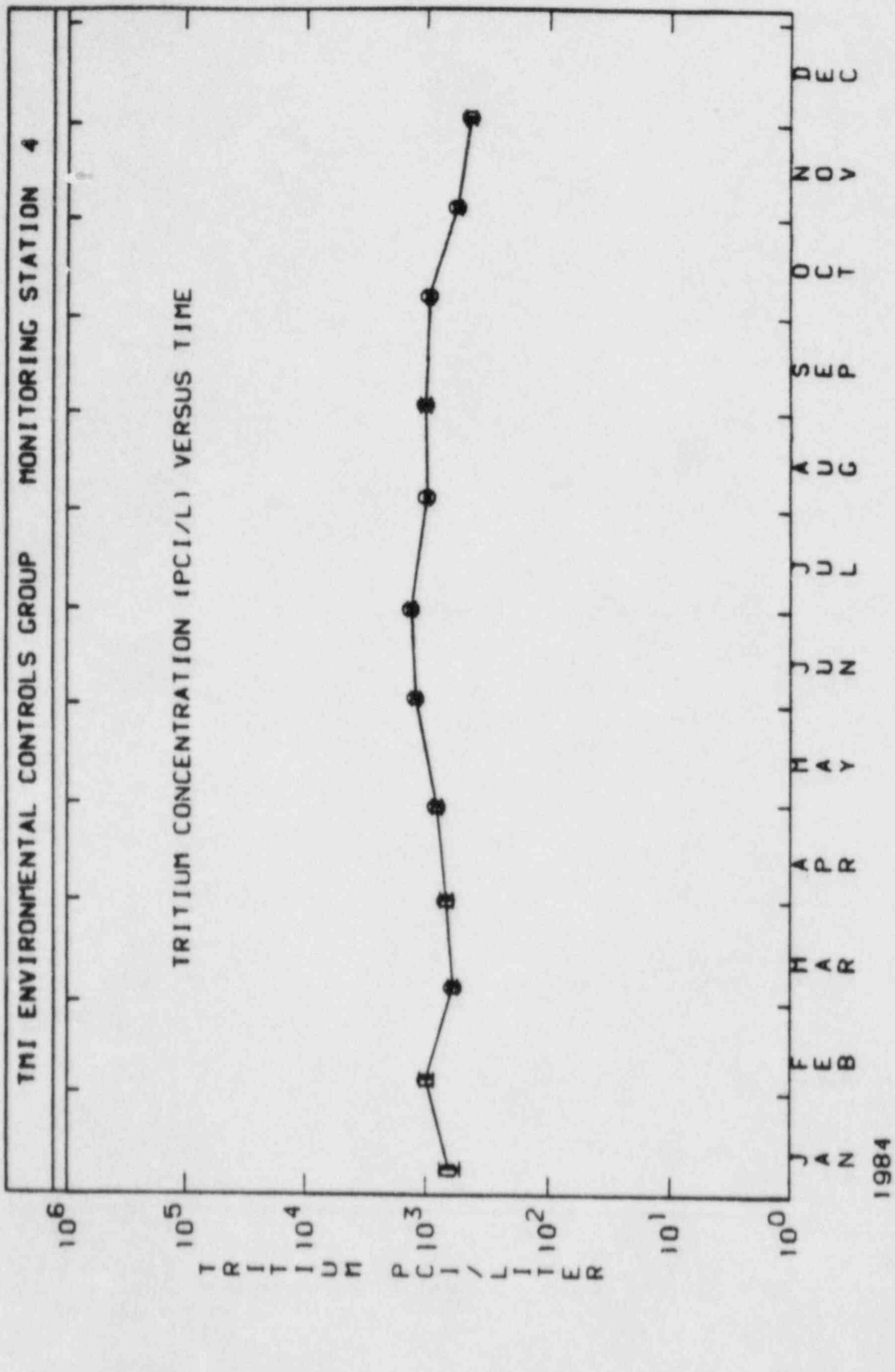
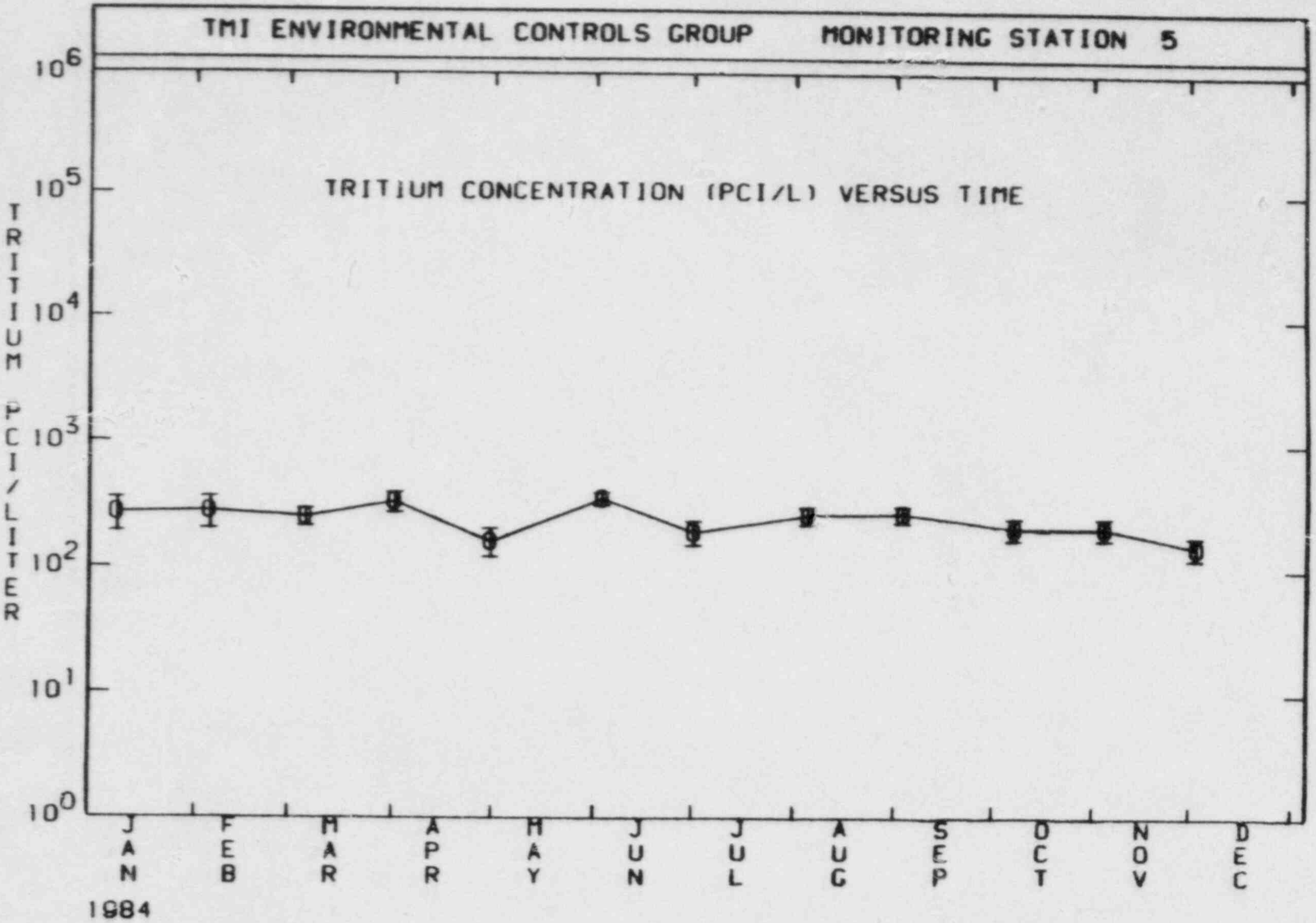
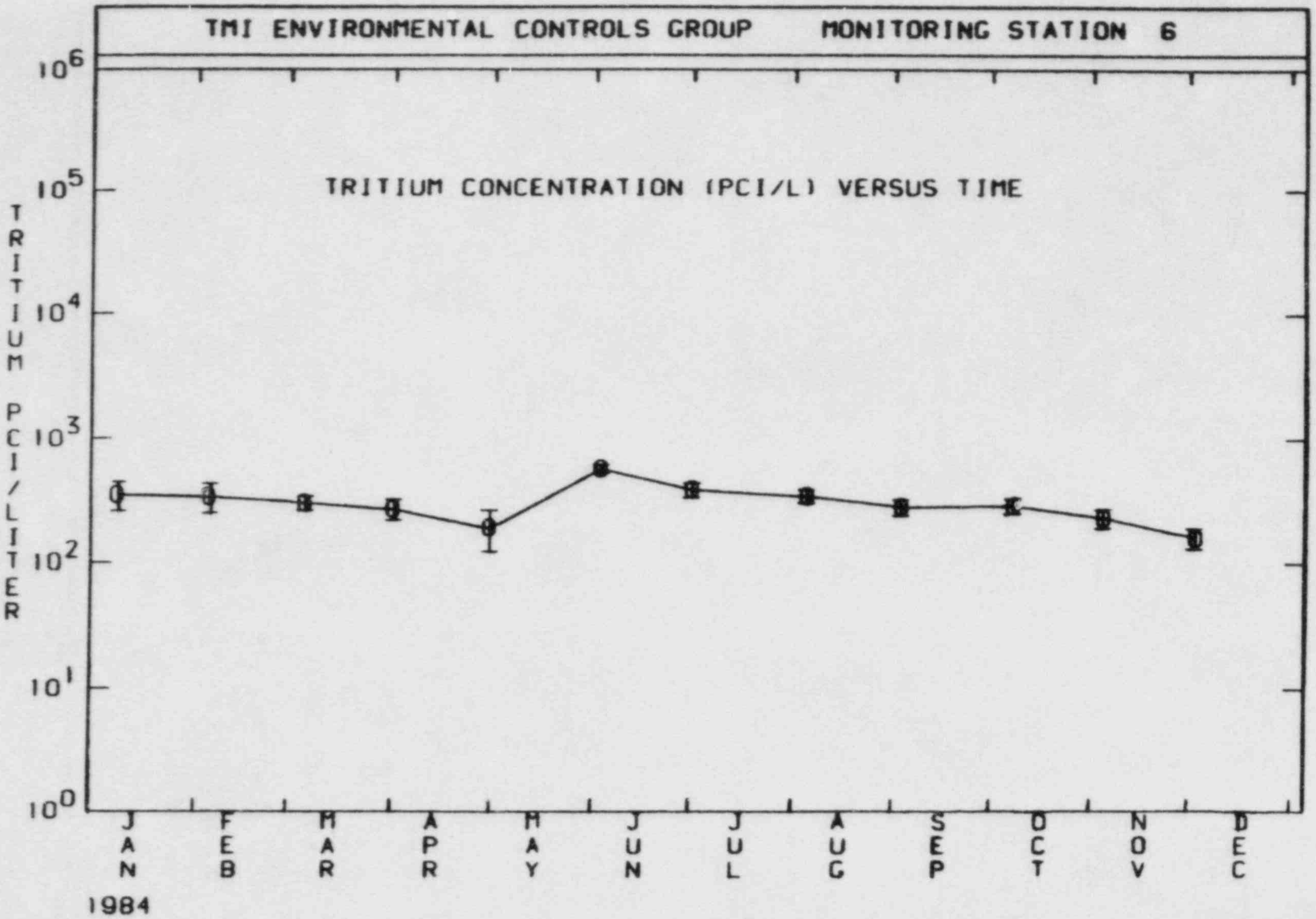

TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 4
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

FIGURE J-6



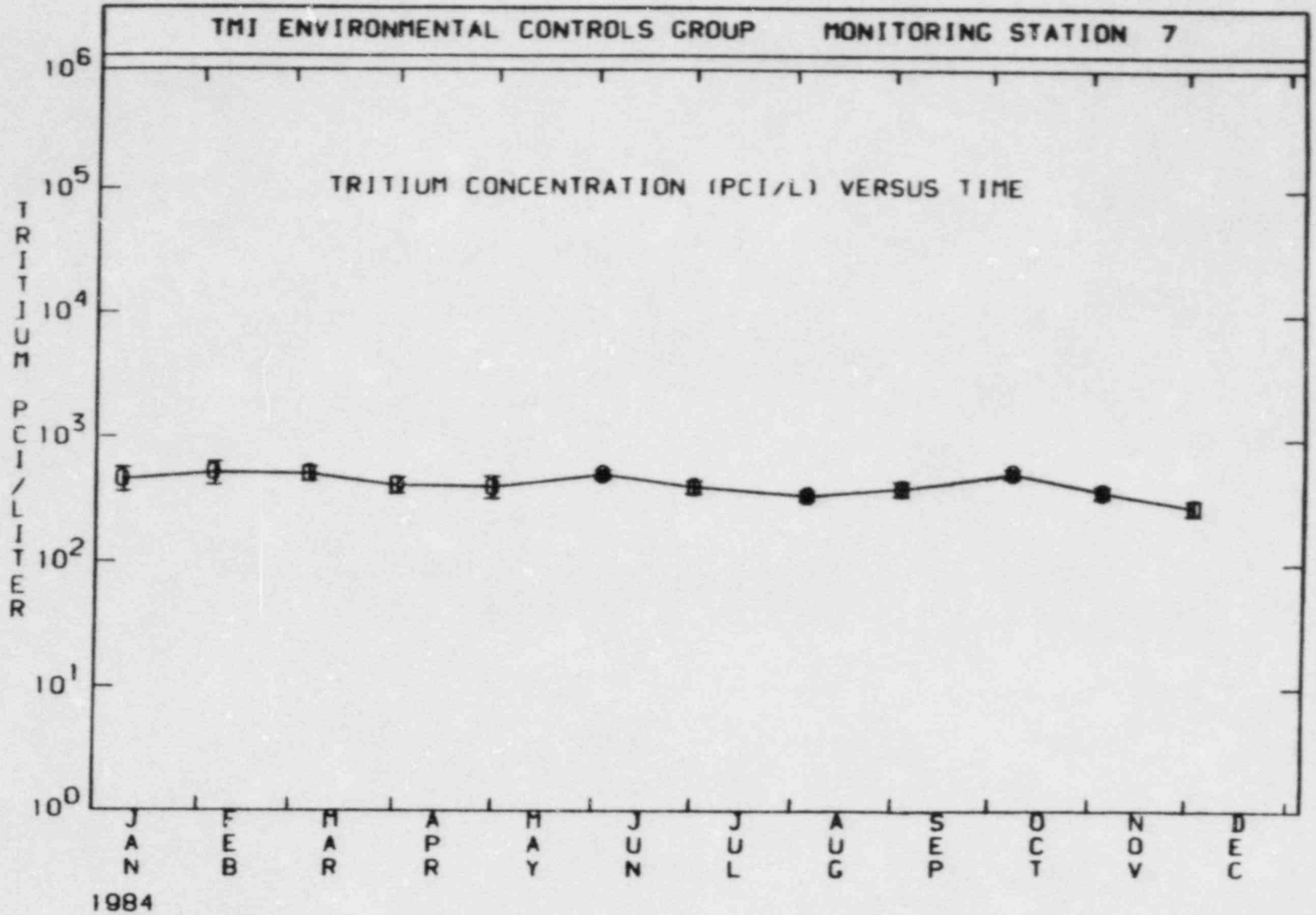
TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 5
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

FIGURE J-7



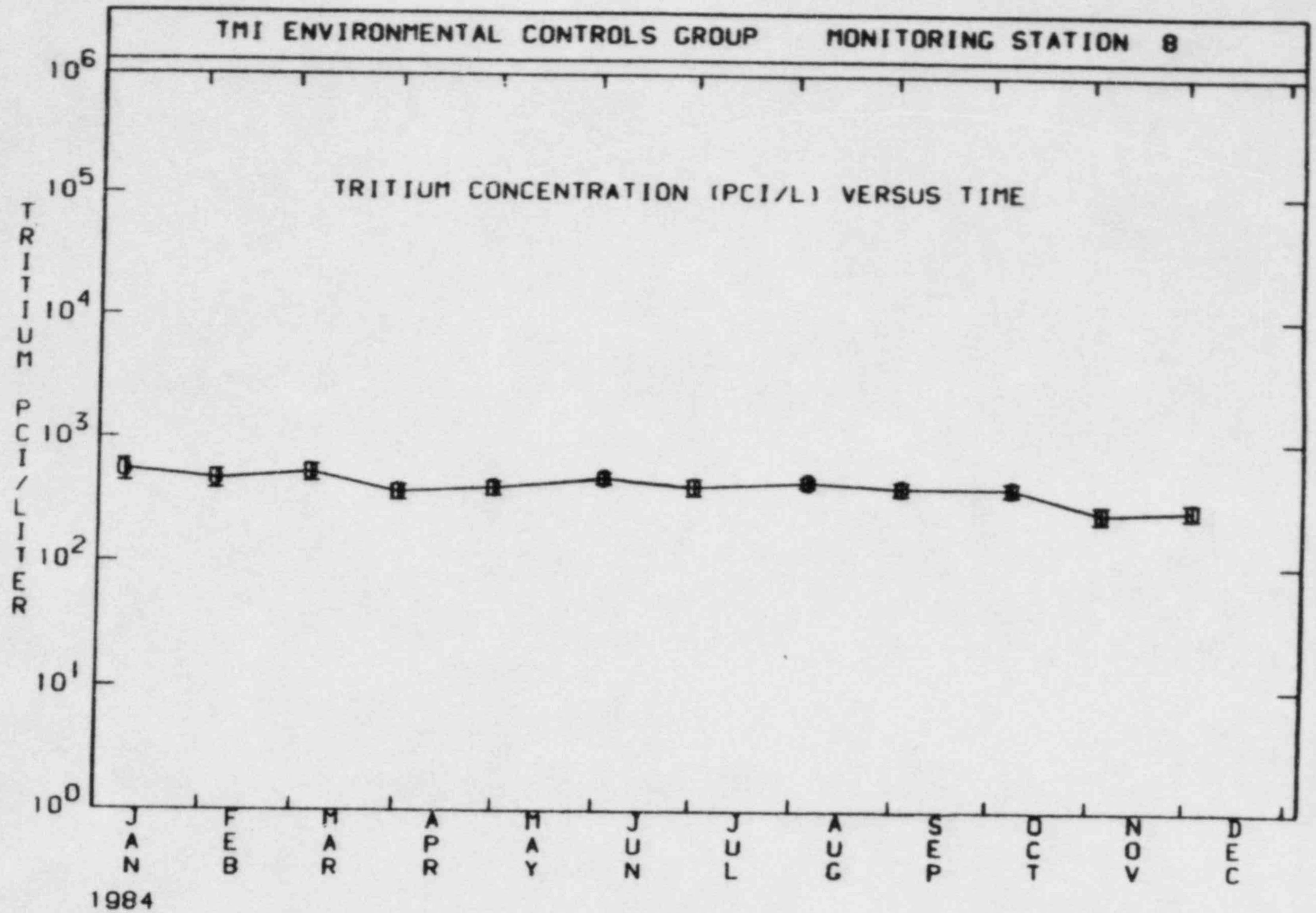
TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 6
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1984

FIGURE J-8



TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 7
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1984

FIGURE J-9



TMI ENVIRONMENTAL CONTROLS GROUP MONITORING STATION 8
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

FIGURE J-10

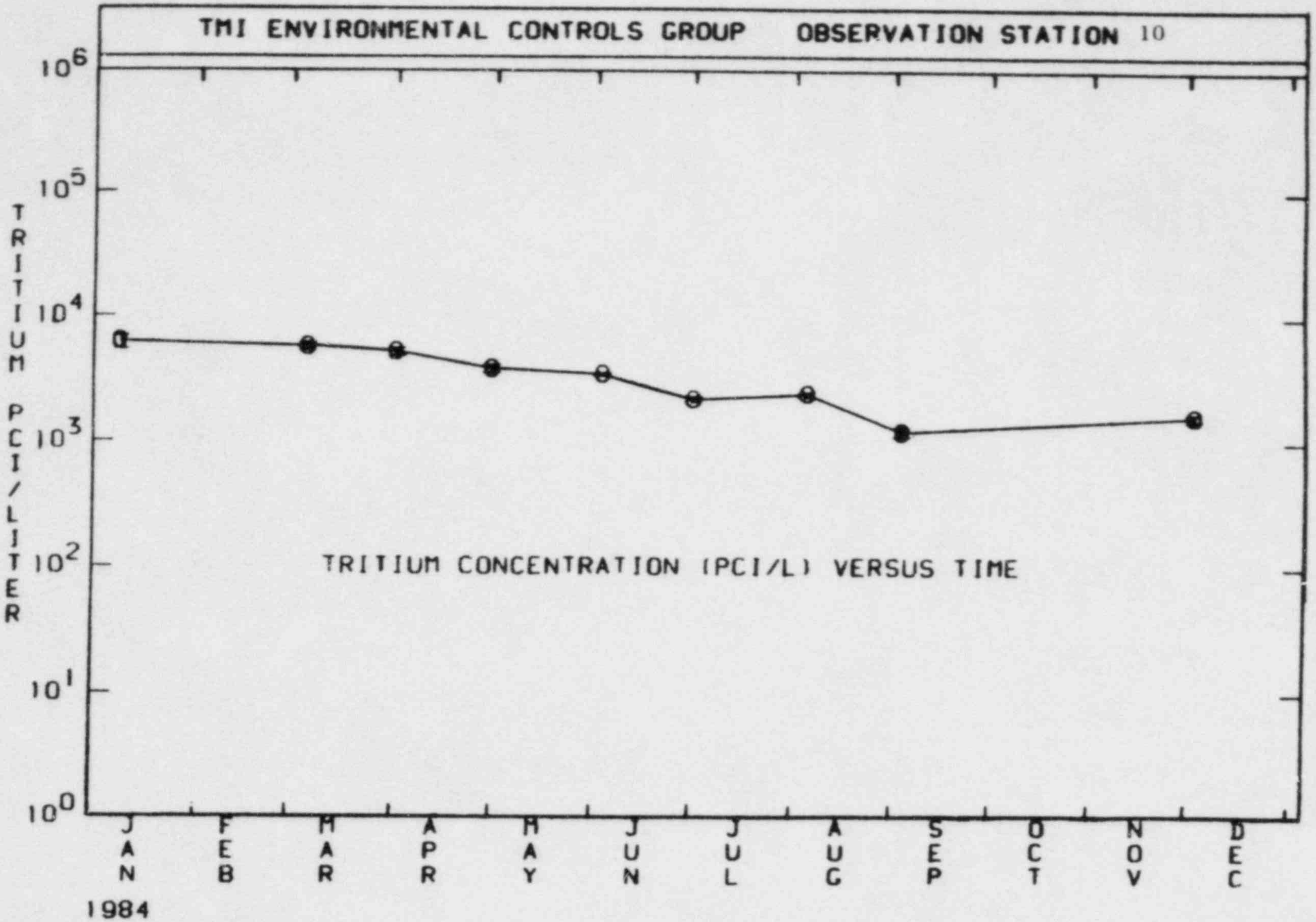

TMI ENVIRONMENTAL CONTROLS GROUP OBSERVATION STATION 10
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1984

FIGURE J-11

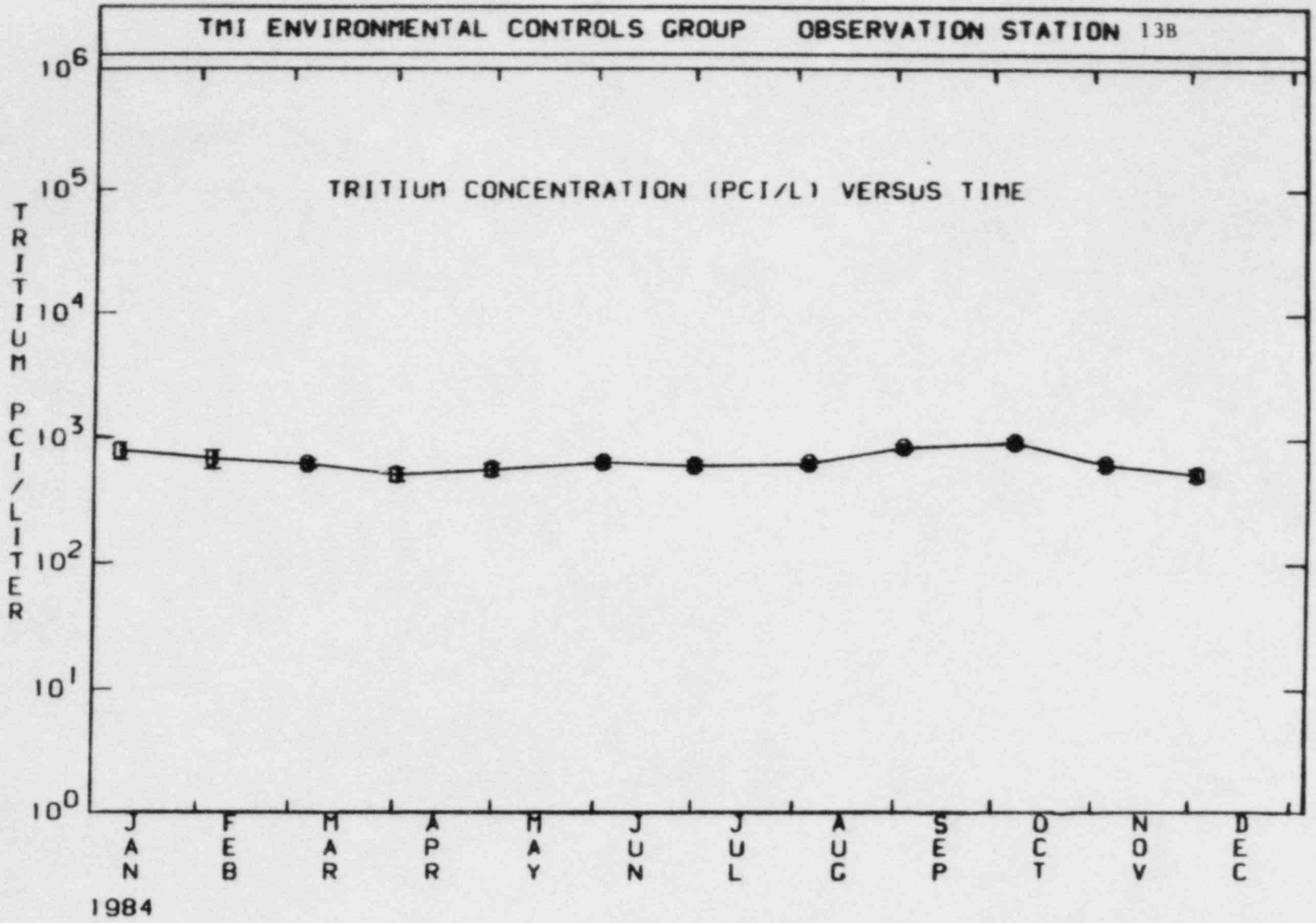
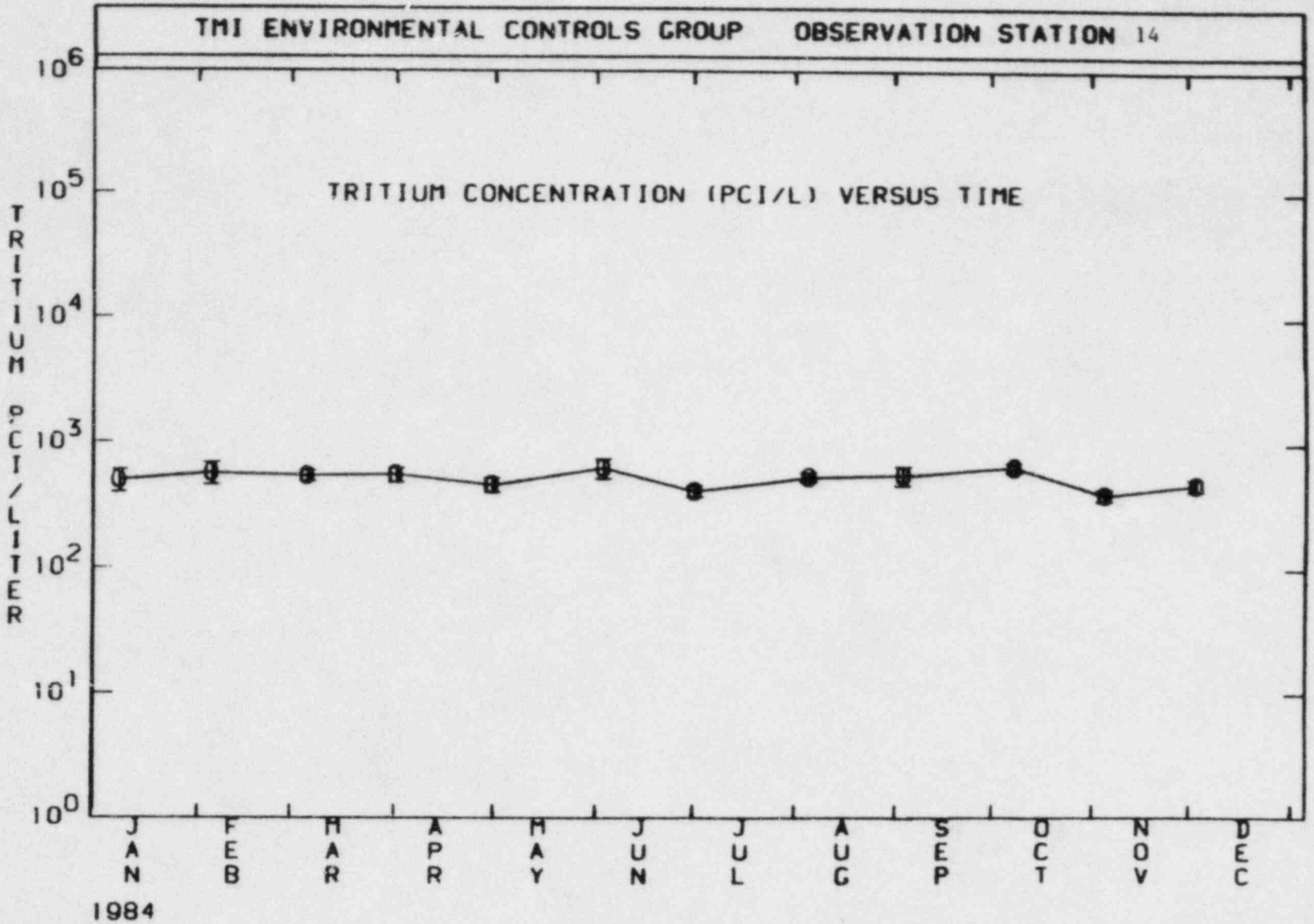

TMI ENVIRONMENTAL CONTROLS GROUP OBSERVATION STATION 13B
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1984

FIGURE J-12



TMI ENVIRONMENTAL CONTROLS GROUP OBSERVATION STATION 14
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM P.CI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

FIGURE J-13

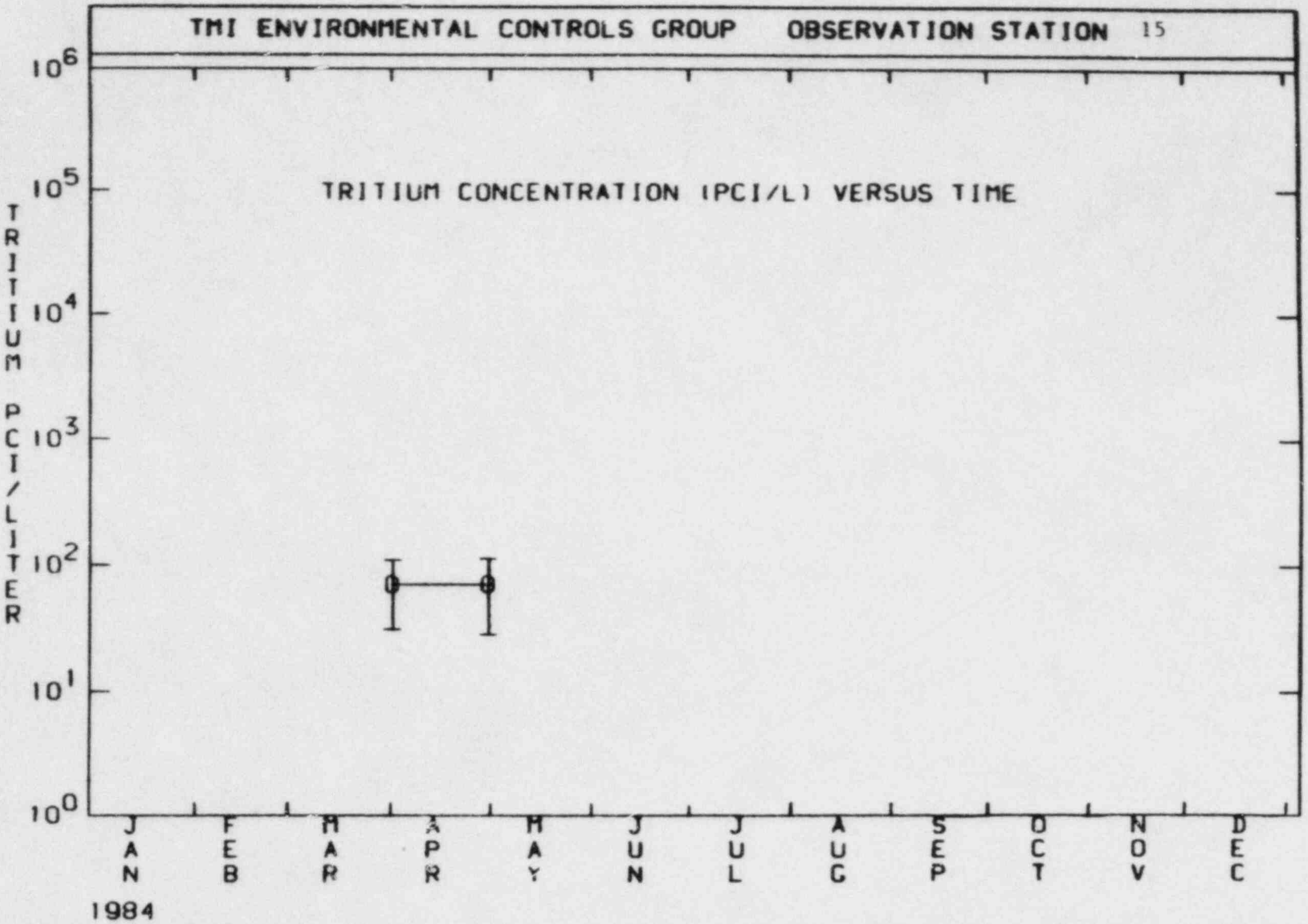
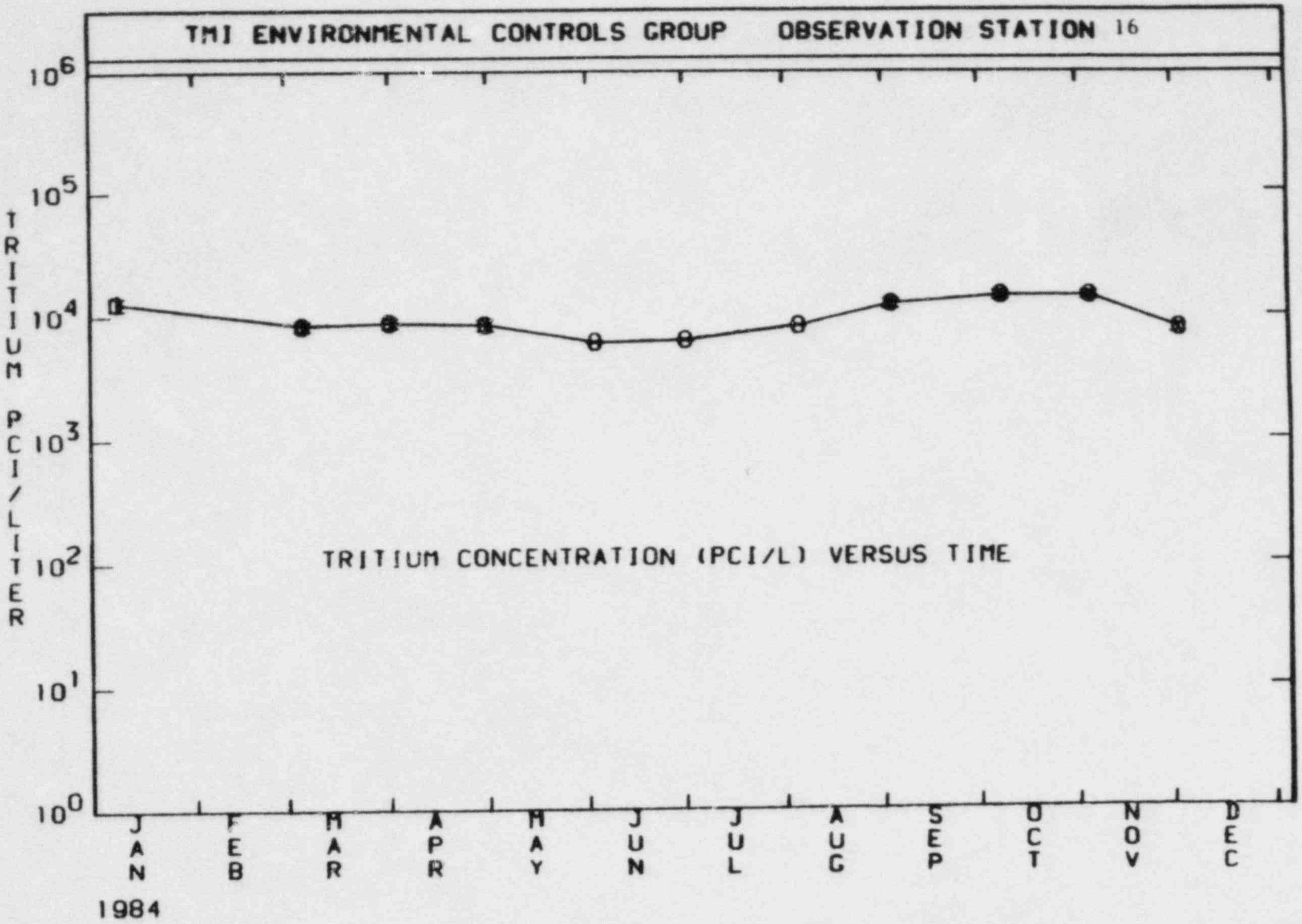

TMI ENVIRONMENTAL CONTROLS GROUP OBSERVATION STATION 15
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1984

FIGURE J-14



TMI ENVIRONMENTAL CONTROLS GROUP OBSERVATION STATION 16
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

FIGURE J-15

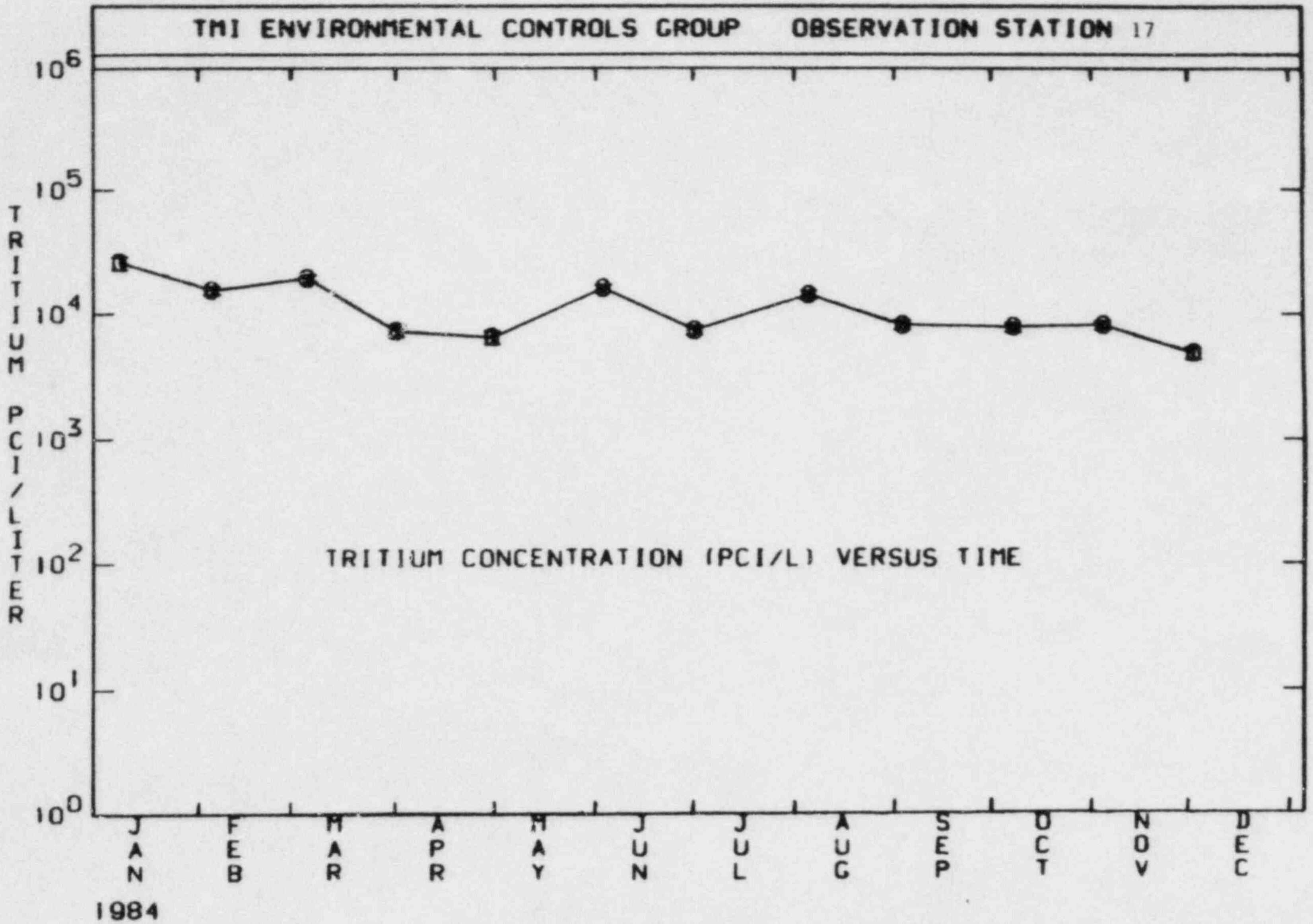
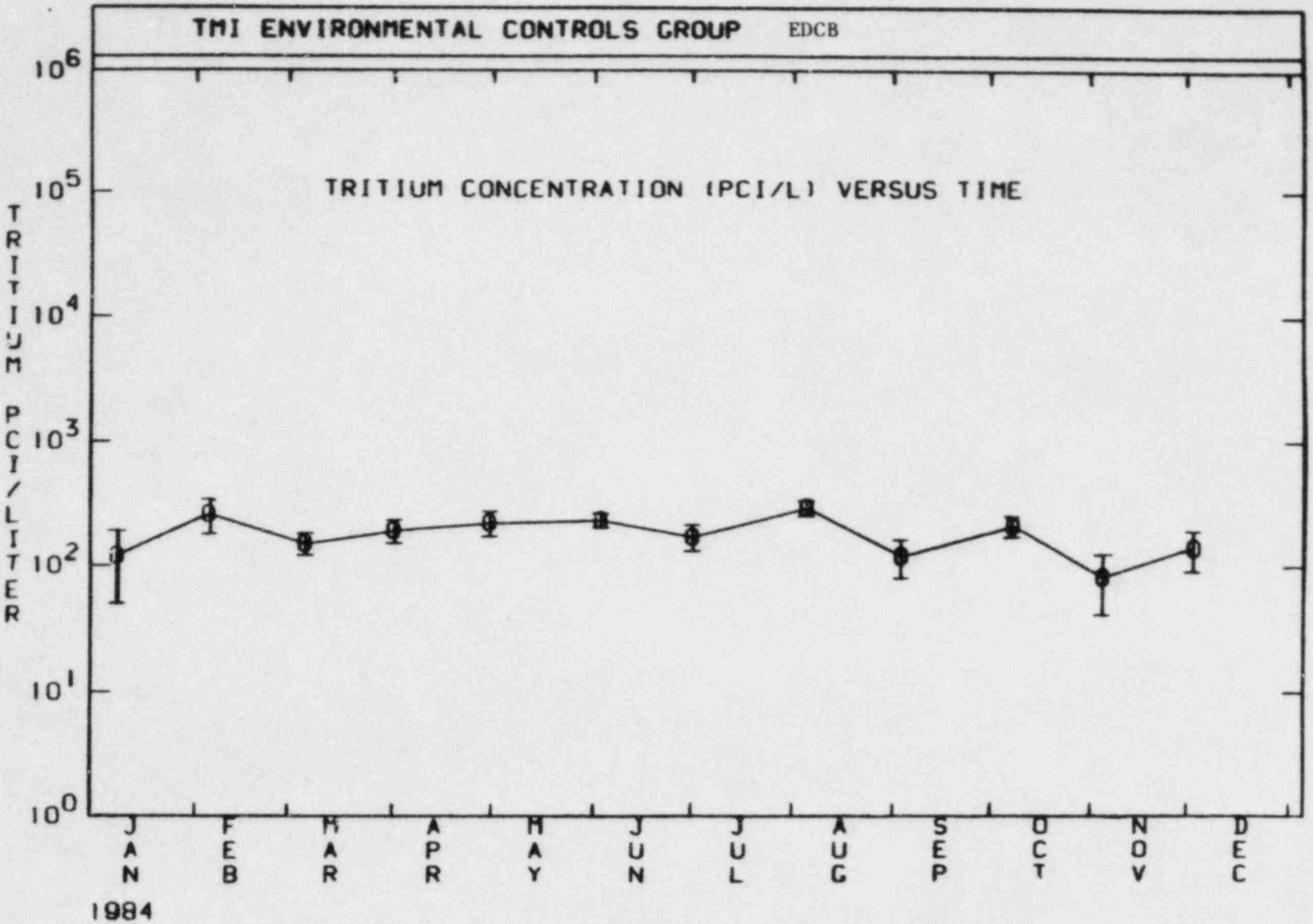

TMI ENVIRONMENTAL CONTROLS GROUP OBSERVATION STATION 17
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

FIGURE J-16



TMI ENVIRONMENTAL CONTROLS GROUP EDCB
TRITIUM CONCENTRATION (PCI/L) VERSUS TIME
TRITIUM PCI/LITER
10^6
10^5
10^4
10^3
10^2
10^1
10^0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1984

APPENDIX K

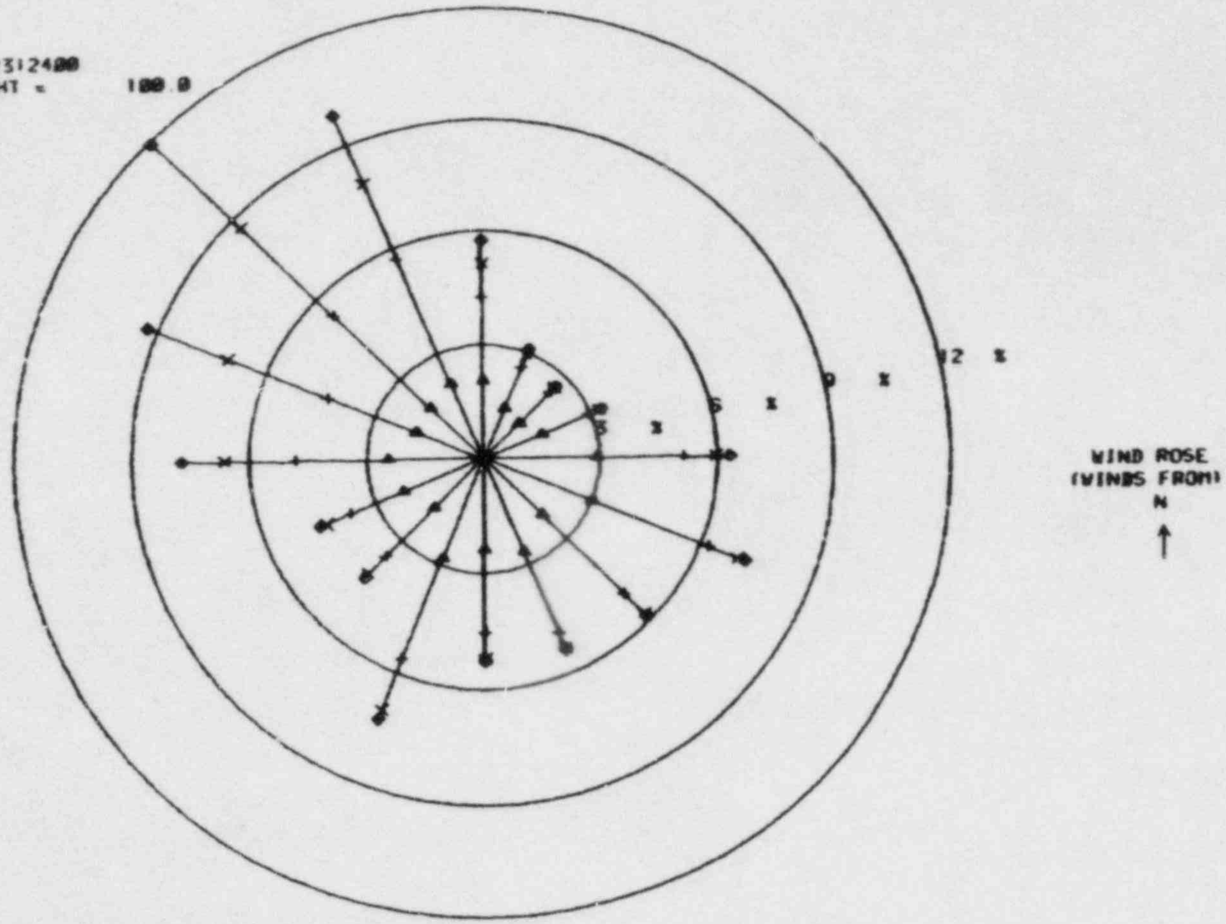
1984

Meteorological Summary

FIGURE K-1

1984 TMI WIND ROSE

84010'0100   8412312400
SPEED SENSOR HEIGHT =   100.0



△WIND SPEED LESS THAN 3.5 MPH
+WIND SPEED LESS THAN 7.5 MPH
×WIND SPEED LESS THAN 12.5 MPH
◇WIND SPEED GREATER THAN 12.5 MPH
SITE. THREE MILE ISLD.

0.3 PERCENT CALMS
(CALMS DEFINED AS SPEED LESS THAN 0.5)
03/08/85 11.53

TABLE K-1

1984 TMI JOINT FREQUENCY TABLES

SITE THREE MILE ISLD. UNIT. UNIT 1 03/08/05 11:50

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: A DT/DZ
ELEVATION SPEED SP100A DIRECTION DI100A LAPSE DT150A

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	8	26	13	12	2	0	61
NNE	4	13	4	1	0	0	22
NE	1	5	2	0	0	0	8
ENE	5	6	2	0	0	0	13
E	3	6	5	0	1	0	15
ESE	12	19	10	0	0	0	41
SE	5	16	10	0	0	0	31
SSE	10	20	2	0	0	0	32
S	12	34	11	0	0	0	57
SSW	16	56	38	8	0	0	118
SW	8	30	10	5	0	0	53
WSW	19	18	7	0	0	0	44
W	19	21	12	7	1	0	60
WNW	30	45	28	8	1	0	112
NW	40	90	73	28	5	0	236
NNW	28	64	54	37	1	0	184
TOTAL	220	469	281	106	11	0	1087

PERIODS OF CALM(HOURS) 44
VARIABLE DIRECTION 66
HOURS OF MISSING DATA 136

SITE THREE MILE ISLD UNIT. UNIT 1 03/08/05 12:01

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: B DT/DZ
ELEVATION SPEED SP100A DIRECTION DI100A LAPSE DT150A

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	8	5	2	3	0	0	18
NNE	4	4	4	0	0	0	12
NE	1	4	2	0	0	0	7
ENE	1	5	1	0	0	0	7
E	4	13	2	0	0	0	19
ESE	2	8	7	0	0	0	17
SE	5	23	3	0	0	0	31
SSE	7	8	2	0	0	0	17
S	9	12	3	0	0	0	24
SSW	10	14	11	4	0	0	39
SW	4	6	5	1	1	0	17
WSW	7	5	3	1	0	0	16
W	5	9	10	9	0	0	33
WNW	4	8	13	10	1	0	36
NW	3	8	19	14	5	0	49
NNW	11	8	9	13	0	0	41
TOTAL	85	140	96	55	7	0	383

PERIODS OF CALM(HOURS) 44
VARIABLE DIRECTION 39
HOURS OF MISSING DATA 136

SITE THREE MILE ISLD UNIT. UNIT 1 03/08/05 12:02

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: C DT/DZ
ELEVATION SPEED SP100A DIRECTION DI100A LAPSE DT150A

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	3	4	1	0	0	0	8
NNE	1	2	1	0	1	0	5
NE	3	0	0	0	0	0	3
ENE	2	3	0	0	0	0	5
E	2	4	1	0	0	0	7
ESE	7	13	5	0	0	0	25
SE	8	5	2	1	0	0	16
SSE	5	6	1	0	0	0	12
S	2	4	1	0	0	0	7
SSW	0	3	9	3	0	0	15
SW	4	3	1	1	0	0	9
WSW	2	2	1	0	0	0	5
W	5	1	4	9	1	0	20
WNW	0	3	9	10	1	0	23
NW	2	3	13	11	0	0	29
NNW	5	6	8	7	0	0	26
TOTAL	51	62	57	42	3	0	215

PERIODS OF CALM(HOURS) 44
VARIABLE DIRECTION 20
HOURS OF MISSING DATA 136

SITE THREE MILE ISLD UNIT. UNIT 1 03/08/05 12:02

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: D DT/DZ
ELEVATION SPEED SP100A DIRECTION DI100A LAPSE DT150A

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	39	34	19	13	8	1	114
NNE	20	15	18	5	1	1	60
NE	23	29	6	3	0	0	61
ENE	41	59	11	4	0	0	115
E	56	92	54	15	2	0	219
ESE	47	127	30	3	4	0	211
SE	26	106	33	4	0	0	169
SSE	35	86	26	2	0	0	149
S	29	55	24	4	0	0	112
SSW	29	64	34	3	0	0	130
SW	17	31	21	3	0	0	72
WSW	23	24	21	7	2	0	77
W	27	42	59	51	6	0	185
WNW	28	57	81	93	25	4	288
NW	19	63	79	95	22	0	278
NNW	28	51	38	39	7	4	167
TOTAL	487	935	546	344	77	10	2399

PERIODS OF CALM(HOURS) 44
VARIABLE DIRECTION 167
HOURS OF MISSING DATA 136

TABLE K-1 (CONT'D)

1984 TMI JOINT FREQUENCY TABLES

SITE THREE MILE ISLD UNIT: UNIT 1 03/08/85 12.03

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: E DT/DZ
ELEVATION: SPEED:SP100A DIRECTION:DI100A LAPSE:DT150A

WIND SPEED(MPH)

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	67	90	32	9	0	2	200
NNE	53	61	13	2	1	0	130
NE	43	48	4	1	0	0	96
ENE	51	32	11	0	0	0	94
E	104	46	10	12	0	0	172
ESE	76	86	17	9	0	0	188
SE	51	79	13	2	0	0	145
SSE	74	60	5	0	0	0	139
S	50	69	19	0	0	0	138
SSW	70	81	28	3	0	0	182
SW	59	62	9	3	0	0	133
WSW	58	65	20	6	0	0	149
W	75	84	66	9	1	0	235
WNW	57	70	102	33	7	0	269
NW	54	94	91	76	13	1	329
NNW	61	99	57	50	5	0	272
TOTAL	1003	1126	497	215	27	3	2871

PERIODS OF CALM(HOURS): 44
VARIABLE DIRECTION 279
HOURS OF MISSING DATA: 136

SITE THREE MILE ISLD UNIT: UNIT 1 03/08/85 12.03

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: F DT/DZ
ELEVATION: SPEED:SP100A DIRECTION:DI100A LAPSE:DT150A

WIND SPEED(MPH)

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	36	27	7	1	0	0	71
NNE	21	4	0	0	0	0	25
NE	21	8	0	0	0	0	29
ENE	31	8	0	0	0	0	39
E	51	22	0	0	0	0	73
ESE	80	14	1	0	0	0	95
SE	48	18	0	0	0	0	66
SSE	59	10	0	0	0	0	69
S	71	8	1	0	0	0	80
SSW	77	17	1	0	0	0	95
SW	41	17	4	1	0	0	63
WSW	41	10	4	0	0	0	55
W	60	32	5	0	0	0	97
WNW	30	22	2	0	0	0	54
NW	34	33	10	3	2	0	82
NNW	43	63	18	8	2	0	134
TOTAL	744	313	53	13	4	0	1127

PERIODS OF CALM(HOURS) 44
VARIABLE DIRECTION 177
HOURS OF MISSING DATA: 136

SITE THREE MILE ISLD UNIT: UNIT 1 03/08/85 12.03

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: G DT/DZ
ELEVATION: SPEED:SP100A DIRECTION:DI100A LAPSE:DT150A

WIND SPEED(MPH)

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	19	5	2	1	0	0	27
NNE	14	1	0	0	0	0	15
NE	22	4	0	0	0	0	26
ENE	11	2	0	0	0	0	13
E	37	8	0	0	0	0	45
ESE	41	8	1	0	0	0	50
SE	41	7	0	0	0	0	48
SSE	44	5	0	0	0	0	49
S	34	4	0	0	0	0	38
SSW	43	7	1	0	0	0	51
SW	25	3	2	0	0	0	30
WSW	44	3	0	0	0	0	47
W	23	14	2	0	0	0	39
WNW	19	7	3	0	0	0	29
NW	13	10	2	2	0	0	27
NNW	10	17	4	1	0	0	32
TOTAL	440	105	17	4	0	0	566

PERIODS OF CALM(HOURS) 44
VARIABLE DIRECTION 84
HOURS OF MISSING DATA 136

SITE: THREE MILE ISLD UNIT: UNIT 1 03/08/85 12.04

HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD = 84010101-84123124
STABILITY CLASS: ALL DT/DZ
ELEVATION: SPEED:SP100A DIRECTION:DI100A LAPSE:DT150A

WIND SPEED(MPH)

WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	180	191	76	39	10	3	499
NNE	125	100	32	8	3	1	269
NE	114	98	14	4	0	0	230
ENE	142	115	25	4	0	0	286
E	257	191	72	27	3	0	550
ESE	265	275	71	12	4	0	627
SE	184	254	61	7	0	0	506
SSE	234	195	36	2	0	0	467
S	207	186	59	4	0	0	456
SSW	245	242	122	21	0	0	630
SW	158	152	52	14	1	0	377
WSW	194	127	56	14	2	0	393
W	214	203	158	85	9	0	669
WNW	160	212	238	154	35	4	803
NW	165	301	287	229	47	1	1030
NNW	186	308	188	155	15	4	856
TOTAL	3030	3150	1547	779	129	13	8648

PERIODS OF CALM(HOURS) 44
VARIABLE DIRECTION 823
HOURS OF MISSING DATA 136

APPENDIX L

1984 REMP Sample Collection and
Analysis Methods

TABLE L-1

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
Gr-α	AP	Quarterly composite of weekly or more frequent samples, continuous air sampling through filter paper	13 weeks of filters per sampling site (7,400 M^3)	Westwood Pro-032-14	Sample leached with acid, evaporated to dryness and placed on planchette for low background gas flow proportional counting
				Midwest 2.1.1	Sample placed on stainless steel planchet and counted in proportional counter
	SW (Intake) EW (Discharge)	Monthly composite	16 liters SW (Intakes) 16 liters EW (Discharge)	Westwood Pro-032-1	Sample evaporated on stainless steel planchette for low background gas flow proportional counting
				Midwest 2.2.2	Same As Above
Gr-β	AP	Continuous weekly or more frequent air sampling through filter paper	1 filter (570 M^3) if weekly	Westwood Pro-032-10	Low-level gas flow proportional counting
				Midwest 2.1.1	Same As Above

TABLE L-1 (Cont'd)

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
Gr-β (cont'd)	SW, EW	Grab or composite sample according to sampling site	16 liters SW 16 liters EW (Monthly)	Westwood Pro-032-1	Sample evaporated on stainless steel planchette for low background gas flow proportional counting
				Midwest 2.2.2	Same As Above
	RW	Monthly composite	8 liters (if possible)	Westwood Pro-032-1	Sample evaporated on stainless steel planchette for low background gas flow proportional counting
				Midwest 2.2.2	Same As Above
Gamma Spectroscopy	AP	Monthly composite of each station	4 weeks (2,300 M^3)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
				Midwest 3.1	Germanium gamma isotopic analysis
	AP	Quarterly composite of each station	13 weeks (7,400 M^3)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
				Midwest 3.1	Germanium gamma isotopic analysis

TABLE L-1 (Cont'd)

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
Gamma Spectroscopy (cont'd)	M, MG	Semimonthly grab of one or composite of several milkings:	4 liters (goat milk) 8 liters (cow milk)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
				Midwest 3.1	Germanium gamma isotopic analysis
	AI	Continuous weekly or more frequent air sampling through charcoal cartridges	1 cartridge (570 M^3)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
				Midwest 3.2	Germanium gamma isotopic analysis
	SW, EW	Grab or composite sample according to sampling site	16 liters SW 16 liters EW (Monthly)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
				Midwest 3.1	Germanium gamma isotopic analysis
	RW	Quarterly composite	24 liters (if possible)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
				Midwest 3.1	Germanium gamma isotopic analysis
	AQF, AQP, AQS	Grab sample semiannually	1 kg (if possible)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
	AQF, AQP	Grab sample semiannually	1 kg (if possible)	Midwest 3.1 Rev. 4	Same As Above

TABLE L-1 (Cont'd)

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
Gamma Spectroscopy (cont'd)	AQS	Grab sample semiannually	1 kg (if possible)	Midwest 3.4	Germanium gamma isotopic analysis
	FPL, FPF	Grab sample annually	1 kg or more (if possible)	Westwood Pro-042-5	Ge(Li) gamma isotopic analysis
				Midwest 3.1	Same As Above
Tritium	SW, EW	Grab or composite sample according to sampling site	16 liters SW 16 liters EW (Monthly)	Westwood Pro-052-2	Water converted to hydrogen, methane added for gas counting
				Midwest 3.8	Sample distilled, mixed with scintillation fluid for scintillation counting
	RW	Quarterly composite	24 liters (if possible)	Westwood Pro-052-2	Water converted to hydrogen, methane added for gas counting
				Midwest 3.8	See Midwest 3.8 above

TABLE L-1 (Cont'd)

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
Sr-89, 90	AP	Quarterly composite of weekly or more frequent samples, continuous air sampling through filter paper	13 weeks of filters per sampling site (7,400 M^3)	Westwood Pro-032-24	Strontium in sample precipitated through a series of precipitations, Sr-90 inferred Y-90 on yttrium oxalate precipitate after 5 days or more ingrowth, low-level beta counting follows. After yttrium separation sample is precipitated with $SrCO_3$ mounted on nylon planchette for counting on low-level beta counter for Sr-89 activity
				Midwest 8.6	Same As Above
	AQF	Grab sample semiannually	1 kg (if possible)	Westwood Pro-032-85	Similar to Sr-89, 90 AP except sample is dried or ashed
				Midwest 8.6	Same As Above
	AQS	Grab sample semiannually	1 kg	Westwood Pro-032-25	Similar to Sr-89, 90 AP
				Midwest 8.6	Same As Above

TABLE L-1 (Cont'd)

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
Sr-89, 90 (cont'd)	AQP	Grab sample semi-annually	1 kg (if possible)	Westwood Pro-032-23	Similar to Sr-89, 90 AP
				Midwest 8.6	Same As Above
	SW, EW	Quarterly composite sample	56 liters SW, EW	Westwood Pro-032-16	Similar to Sr-89, 90 AP
				Midwest 8.4	Same As Above
	RW	Semiannually composite	48 liters	Westwood Pro-032-16	Similar to Sr-89, 90 AP
				Midwest 8.4	Same As Above
	M, MG	Quarterly composite sample by station	48 liters (cow milk) 24 liters (goat milk)	Westwood Pro-032-18	Strontium precipitated as $Sr(NO_3)_2$, barium and iron scavenged, 5 days or longer yttrium ingrowth, Sr-90 on yttrium oxalate mounted and low-level beta counted Sr-89 precipitated as $SrCO_3$ mounted and counted as above
				Midwest 8.6	See Sr-89, 90 AP above

TABLE L-1 (Cont'd)

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
I-131	SW, EW	Grab or composite sample according to sampling site	8 liters (if possible)	Westwood Pro-032-11	Anion-exchange resin, reduction, extraction, palladium precipitate; low-level beta counting
				Midwest 7.4	Same As Above
	FPL, FPF	Grab sample annually	1 kg or more (if possible)	Westwood Pro-032-12	Carrier added, leached, evaporated and fused. Residue dissolved, filtered and reduced with hydroxylamine hydrochloride precipitate as palladium iodide for counting on low-level beta counter.
				Midwest 7.7 7.4	Same As Above
	M, MG	Semimonthly grabs	4 liters (goat milk) 8 liters (cow milk)	Westwood Pro-032-11	Anion-exchange resin, reduction, extraction, palladium precipitate; low-level beta counting
				Midwest 3.9	Same As Above

TABLE L-1 (Cont'd)

TMINS

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

SUMMARY OF SAMPLE COLLECTION AND ANALYSIS METHODS

1984

Analysis	Sample Medium	Sampling Method	Approximate Sample Size Collected	Teledyne Procedure Number	Procedure Abstract
TLD	ID	Dosimeters exchanged quarterly	TLD	TMI-EC 9420-IMP-4522.02 Rev. 10 9420-OPS-4524.02 Rev. 0	Thermoluminescent dosimetry
				Westwood Pro-342-17	Thermoluminescent dosimetry
P-32	EW, Intake	Monthly composite	16 liters	Westwood Pro-032-43	Phospherous carrier added; precipitated. Counted on low-level beta counter. Recounted after two weeks to verify radiochemical purity.
				Midwest P-01	Same As Above
Fe-55	EW, Intake	Monthly	16 liters	Westwood Pro-032-62	Stable iron and NHO_3 added and through series of extractions Fe is electro-plated on 1-inch copper disc; counted on NaI detector
				Midwest uses Westwood Pro-032-62	Same As Above

APPENDIX M

1984

TLD Quarterly Data

TABLE M

1984
TMINS REMP QUARTERLY TLD RESULTS

(DOSE IN MREM/STD MONTH)

Location	Station	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
N. Weather Station TMI	A1-1	4.45	4.84	4.91	5.03
N. Weather Station TMI	A1-1Q	4.60	5.01	5.04	5.25
Perimeter Fence TMI	A1-4	*	4.06	4.32	4.49
Mill Street Substation	A3-1	3.87	3.97	4.01	4.00
Vine Street	A5-1	4.52	5.25	5.26	5.57
North Bridge TMI	B1-1	3.75	3.82	3.93	4.31
North Bridge TMI	B1-1Q	3.86	4.20	4.32	4.25
Top of Dike TMI	B1-2	*	4.18	4.22	4.42
Perimeter Fence TMI	B1-3	*	3.88	3.92	4.22
School House Rd & Miller Rd	B5-1	4.52	5.04	5.15	5.18
W. Areba Avenue (Hershey)	B10-1	4.63	4.75	4.47	5.58
Route 441 - North Gate	C1-1	4.13	4.74	4.76	4.88
Route 441 - North Gate	C1-1Q	4.94	5.41	5.68	5.20
Top of Dike TMI	C1-2	*	3.84	4.30	4.11
Kennedy Lane	C5-1	4.24	5.06	4.06	5.03
Schenk's Church	C8-1	4.90	5.75	5.37	6.24
Cumberland Street (Lebanon)	C20-1	3.58	4.22	4.48	4.51
Top of Dike TMI	D1-1	3.56	4.62	4.57	4.76
Top of Dike TMI	D1-1Q	4.26	5.41	4.47	4.40
Laurel Road	D1-2	3.85	6.51	4.95	5.17
Beagle Road	D6-1	4.52	7.10	5.98	6.10
Route 241 (Bellaire)	D9-1	4.66	7.14	6.74	6.58

TABLE M (cont'd)

1984
TMINS REMP QUARTERLY TLD RESULTS

(DOSE IN MREM/STD MONTH)

Location	Station	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Route 241 (Lawn)	D15-1	4.12	6.30	5.47	5.56
Route 241 (Lawn)	D15-1Q	5.02	5.46	5.65	5.30
Top of Dike TMI	E1-1	4.37	6.08	4.41	5.23
Top of Dike TMI	E1-1Q	5.31	6.08	5.09	5.25
Observation Center	E1-2	3.57	4.97	4.32	4.72
Observation Center	E1-2Q	4.41	4.68	4.89	4.70
Top of Dike TMI	E1-4	*	6.09	4.77	5.66
Zeager Road	E5-1	4.16	6.04	5.10	5.36
Hummelstown St (E-town)	E7-1	3.68	5.97	5.05	5.24
Route 441 Substation	F1-1	3.76	5.42	6.13	4.91
Route 441 Substation	F1-1Q	4.52	4.63	4.96	4.65
Top of Dike TMI	F1-2	*	7.76	6.11	8.22
Masonic Homes	F5-1	4.28	6.23	5.77	6.83
Donegal Springs Road	F10-1	4.86	6.45	5.79	7.29
Steel Way & Loop Road	F25-1	4.41	6.09	5.19	5.61
Route 441 (Red Hill)	G1-2	4.31	5.46	4.51	4.83
Route 441 (Red Hill)	G1-2Q	*	4.67	4.91	5.00
Top of Dike TMI	G1-3	*	4.93	5.60	9.20
Risser Road	G5-1	4.22	5.48	4.49	5.46
Drager Farm (Marietta)	G10-1	6.12	7.86	7.01	7.23
Drager Farm (Marietta)	G10-1Q	6.81	7.50	7.89	7.70
Columbia Water Treatment	G15-1	4.32	5.65	5.51	5.66

TABLE M (cont'd)

1984
TMINS REMP QUARTERLY TLD RESULTS

(DOSE IN MREM/STD MONTH)

Location	Station	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Pole #ME-33-T-28 SSE TMI	H1-1	4.04	5.70	4.65	5.45
Top of Dike TMI	H1-9	*	5.22	5.06	5.32
Falmouth-Collins Substation	H3-1	3.32	4.55	3.51	5.02
Falmouth-Collins Substation	H3-1Q	3.57	3.71	3.73	3.60
Brunner Island	H5-1	3.41	3.33	4.20	3.69
Starview	H8-1	6.12	7.03	**	7.48
Orchard & Stonewood Road	H15-1	4.67	5.16	6.53	5.40
South TMI	J1-1	3.88	4.19	5.53	5.34
Wooden Post TMI	J1-3	*	3.68	3.59	3.37
Conewago Road	J5-1	4.40	4.74	5.26	7.55
Conewago Road	J5-1Q	5.26	5.44	**	5.60
Route 921 (Manchester)	J7-1	3.80	3.90	4.22	3.80
North York Substation	J15-1	4.57	5.89	6.32	6.17
Pole #ME-33-T-28 S. Parking Lot TMI	K1-2	2.95	3.57	3.59	3.87
Perimeter Fence TMI	K1-4	*	4.10	4.09	4.65
Perimeter Fence TMI	K1-5	*	3.90	3.87	5.06
S. End Shelley Island	K2-1	4.96	5.35	5.46	5.68
Strinestown	K5-1	5.80	7.24	6.16	7.73
Strinestown	K5-1Q	6.17	6.47	7.00	6.85
Coppenhaffer Road	K8-1	4.44	4.99	4.72	7.32
Alta Vista Road	K15-1	3.57	5.19	4.09	4.83
MDCT TMI	L1-1	3.87	5.80	3.92	4.42

TABLE M (cont'd)

1984
TMINS REMP QUARTERLY TLD RESULTS

(DOSE IN MREM/STD MONTH)

Location	Station	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
MDCT TMI	L1-1Q	4.69	**	4.69	4.45
Beech Island	L1-2	3.49	4.63	4.11	3.98
River Road	L2-1	3.91	6.85	5.03	4.92
Stevens and Wilson Roads	L5-1	3.25	5.64	5.37	4.32
Rohler's Church Road	L8-1	3.61	5.38	4.82	4.98
Mt. Royal	L15-1	3.95	**	4.91	4.89
Goldsboro Air Station	M2-1	2.77	5.54	4.10	3.73
Goldsboro Air Station	M2-1Q	3.77	3.96	4.42	4.10
Newberry School	M5-1	3.65	5.15	5.51	5.52
Alpine Road (Maytown)	M9-1	5.30	5.73	6.89	7.03
Rossville	M15-1	4.45	5.99	5.78	5.30
Due West on Shelley Island	N1-1	4.41	5.08	4.60	5.17
Screenhouse Fence TMI	N1-3	*	4.16	3.98	5.14
Goldsboro Marina	N2-1	4.12	5.93	4.74	5.75
Goldsboro Marina	N2-1Q	4.61	4.94	5.07	4.80
Yocumtown	N5-1	4.38	5.57	3.97	4.84
Lewisberry	N8-1	4.55	5.79	4.91	5.80
Mt. Allen	N15-1	5.39	7.50	6.72	6.85
Lisburn	N15-2	5.01	6.15	5.70	6.61
Shelley Island	P1-1	4.27	5.32	4.45	5.72
Tree Fork (N. of Goldsboro)	P2-1	4.41	5.54	4.80	6.58
Tree Fork (N. of Goldsboro)	P2-1Q	5.10	5.06	5.63	5.25

TABLE M (cont'd)

1984
TMINS REMP QUARTERLY TLD RESULTS

(DOSE IN MREM/STD MONTH)

Location	Station	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Beinhower Road	P5-1	3.82	4.45	4.44	5.14
Reeser's Summit	P8-1	3.80	4.59	5.14	4.97
Penn Harris Motel	P15-1	5.12	6.95	7.03	6.87
Shelley Island	Q1-1	4.13	5.43	4.81	4.80
Perimeter Fence TMI	Q1-2	*	3.99	4.01	5.07
West Shore along river	Q2-1	4.31	5.70	4.99	5.65
Lumber Street (Highspire)	Q5-1	4.33	5.46	4.56	6.60
Steelton Water Treatment	Q9-1	4.57	5.81	5.01	6.50
West Fairview	Q15-1	5.00	6.32	5.53	6.34
West Fairview	Q15-1Q	5.61	5.68	5.82	5.70
Penn & Forster Streets	Q15-2	4.14	5.11	4.30	5.14
North Boat Dock TMI	R1-1	4.34	5.18	4.37	4.98
North Boat Dock TMI	R1-1Q	4.31	4.57	4.53	4.40
Henry Island	R1-2	3.90	4.71	4.10	4.17
Route 441 & Airport Expressway	R5-1	4.05	5.71	5.06	5.24
Rutherford Heights	R9-1	4.68	5.94	5.13	5.53
Route 22 & Colonial Road	R15-1	4.05	5.15	4.62	5.20

* Station not yet installed

** Vandalized

FIGURE M-1

TLD DATA
GRAPHS OF STATIONS
1984

Horizontal Axis-Quarters
Vertical Axis-mrem/Std. Mo.
*Denotes Control Station

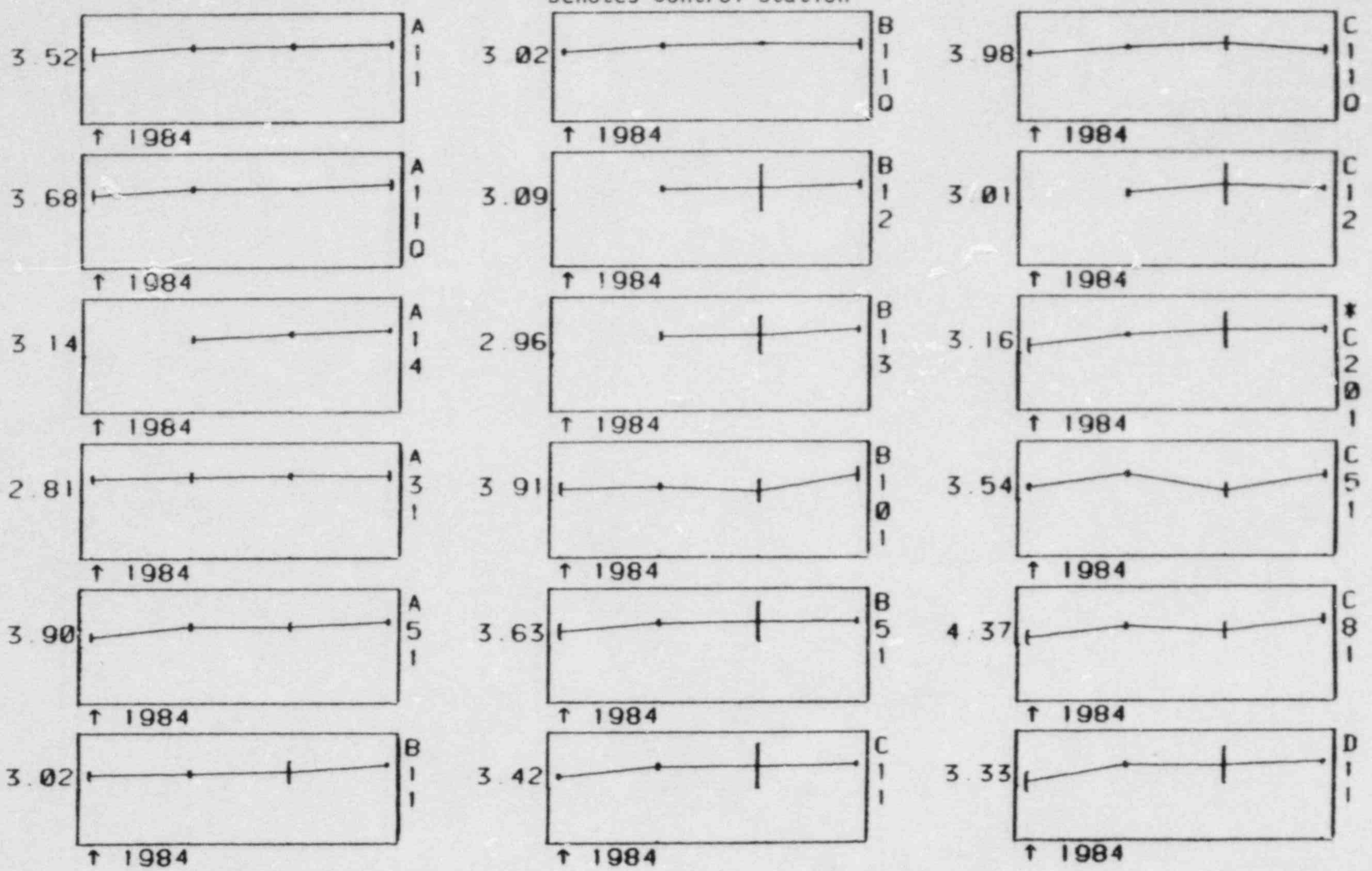


FIGURE M-1

TLD DATA
GRAPHS OF STATIONS
1984

Horizontal Axis-Quarters
Vertical Axis-mrem/Std. Mo.
*Denotes Control Station

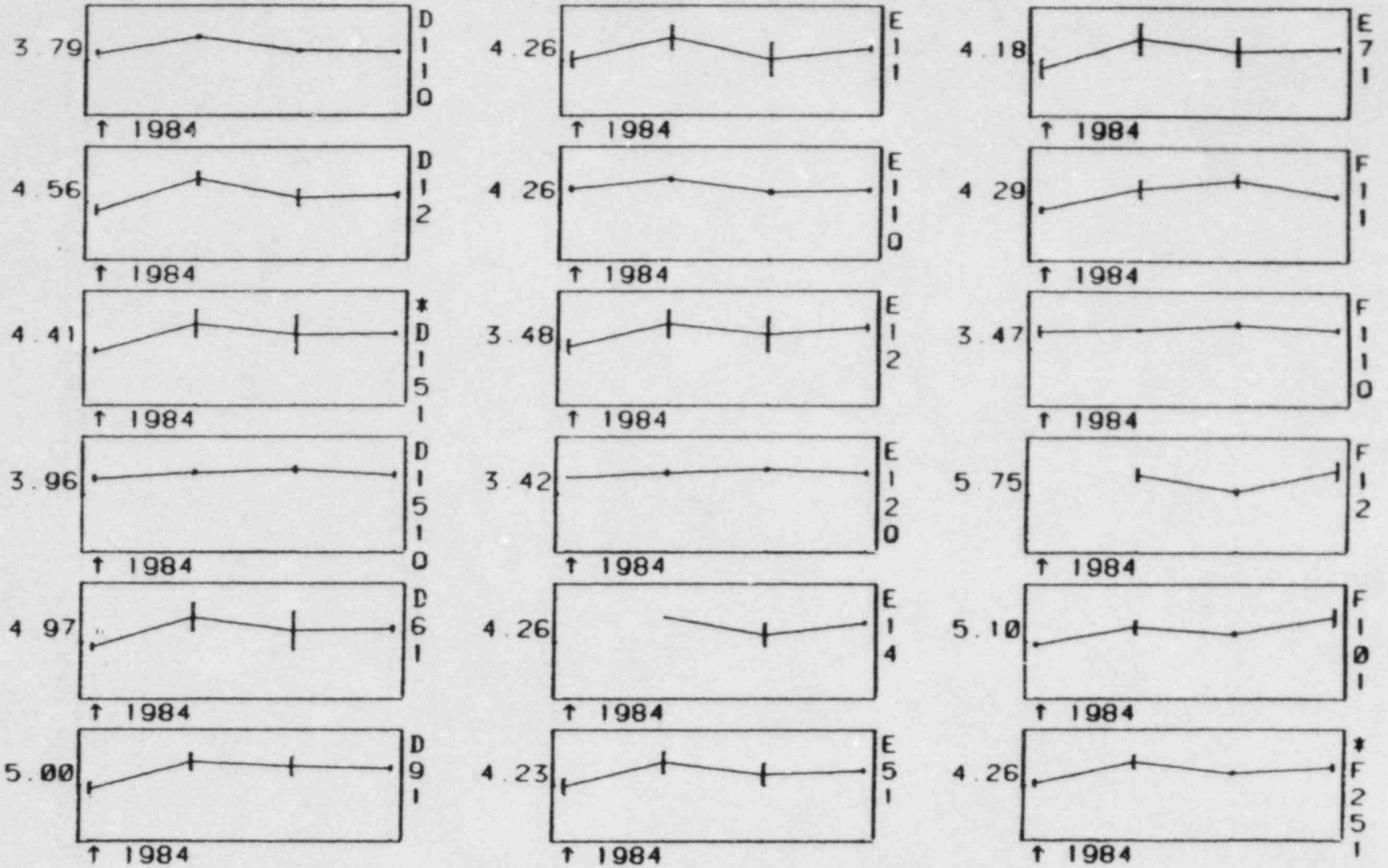


FIGURE M-1

TLD DATA
GRAPHS OF STATIONS
1984
Horizontal Axis-Quarters
Vertical Axis-mrem/Std. Mo.
*Denotes Control Station

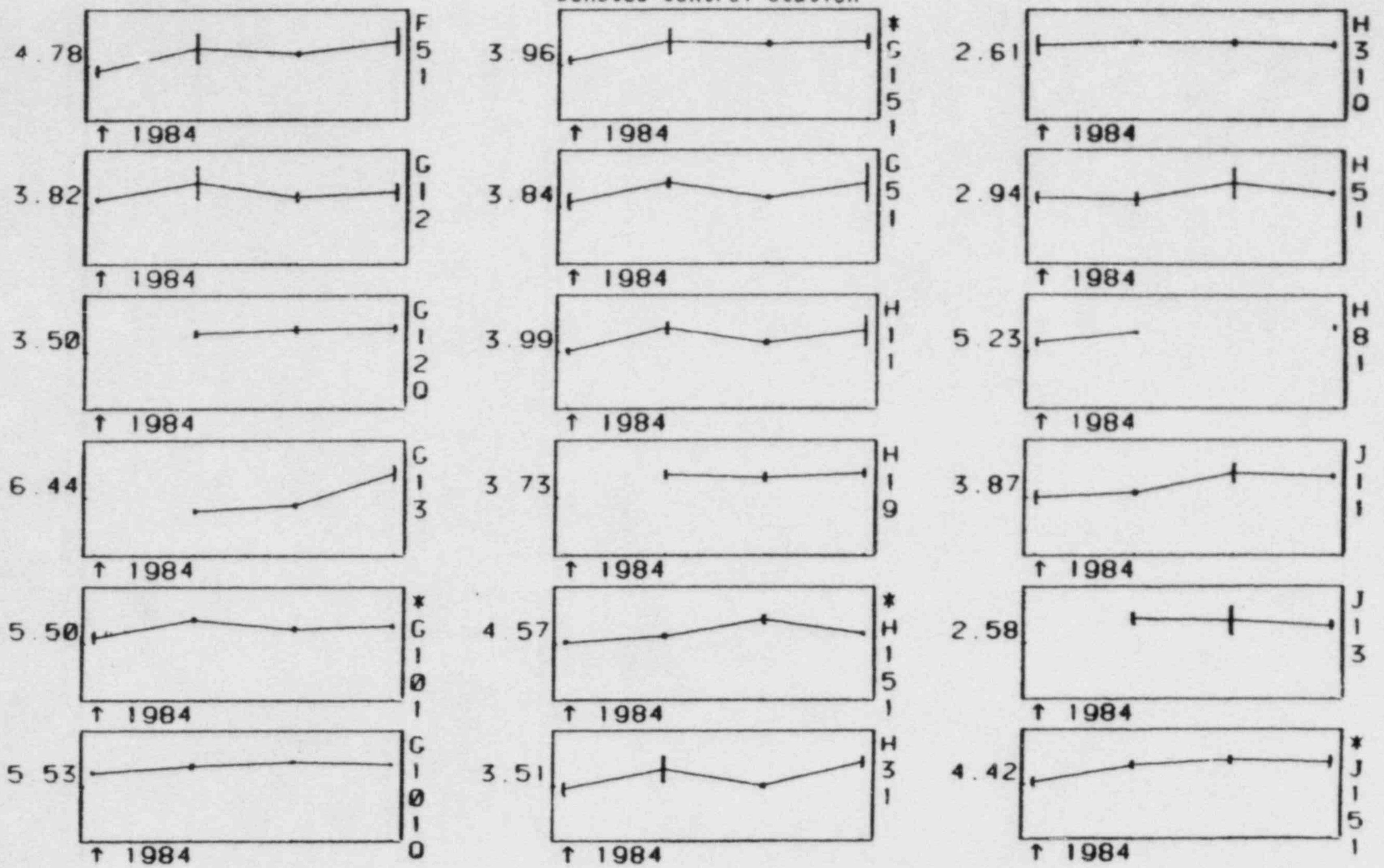


FIGURE M-1

TLD DATA
GRAPHS OF STATIONS
1984
Horizontal Axis-Quarters
Vertical Axis-mrem/Std. Mo.
*Denotes Control Station

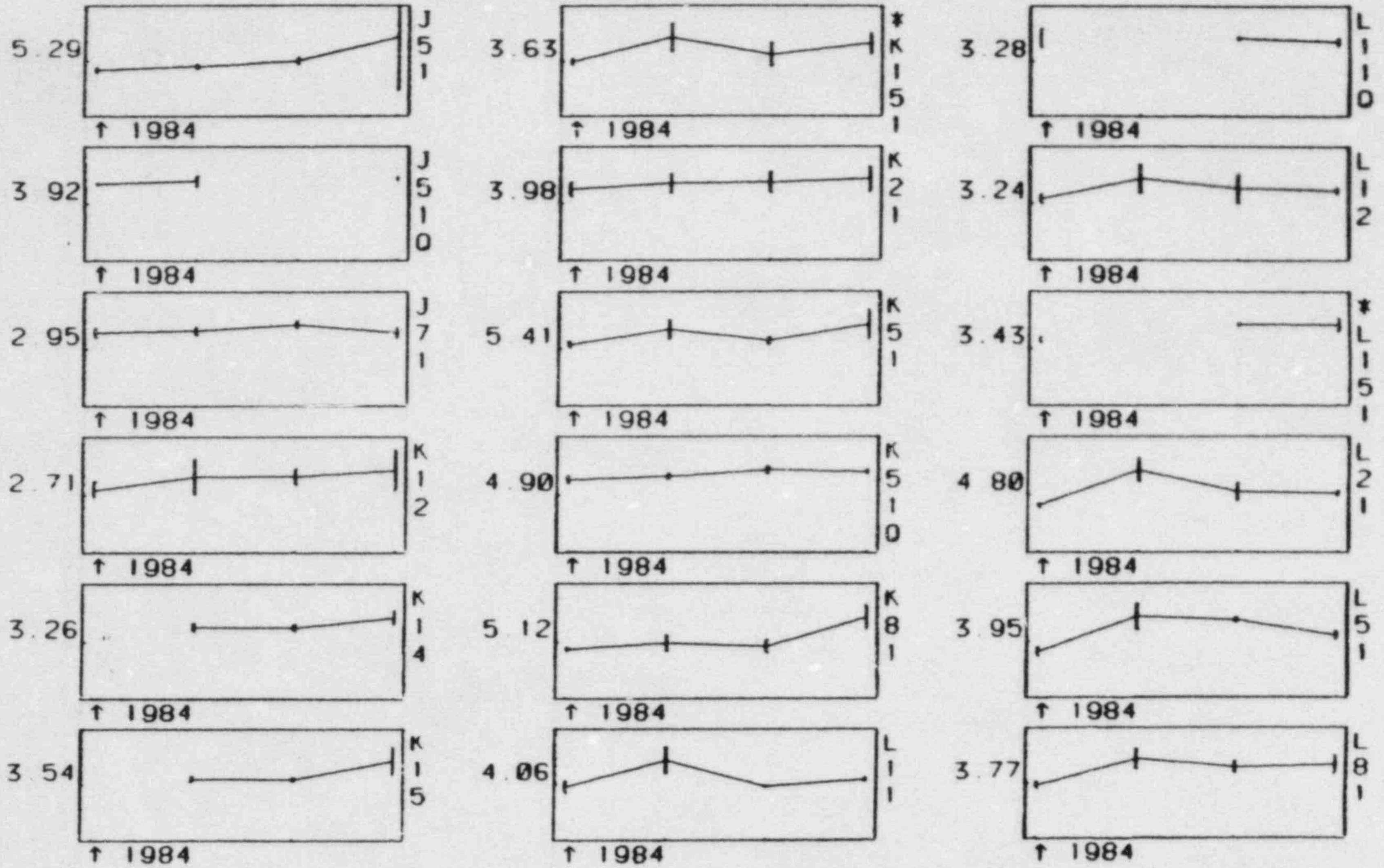


FIGURE M-1

TLD DATA
GRAPHS OF STATIONS
1984

Horizontal Axis-Quarters
Vertical Axis-mrem/Std. Mo.
*Denotes Control Station

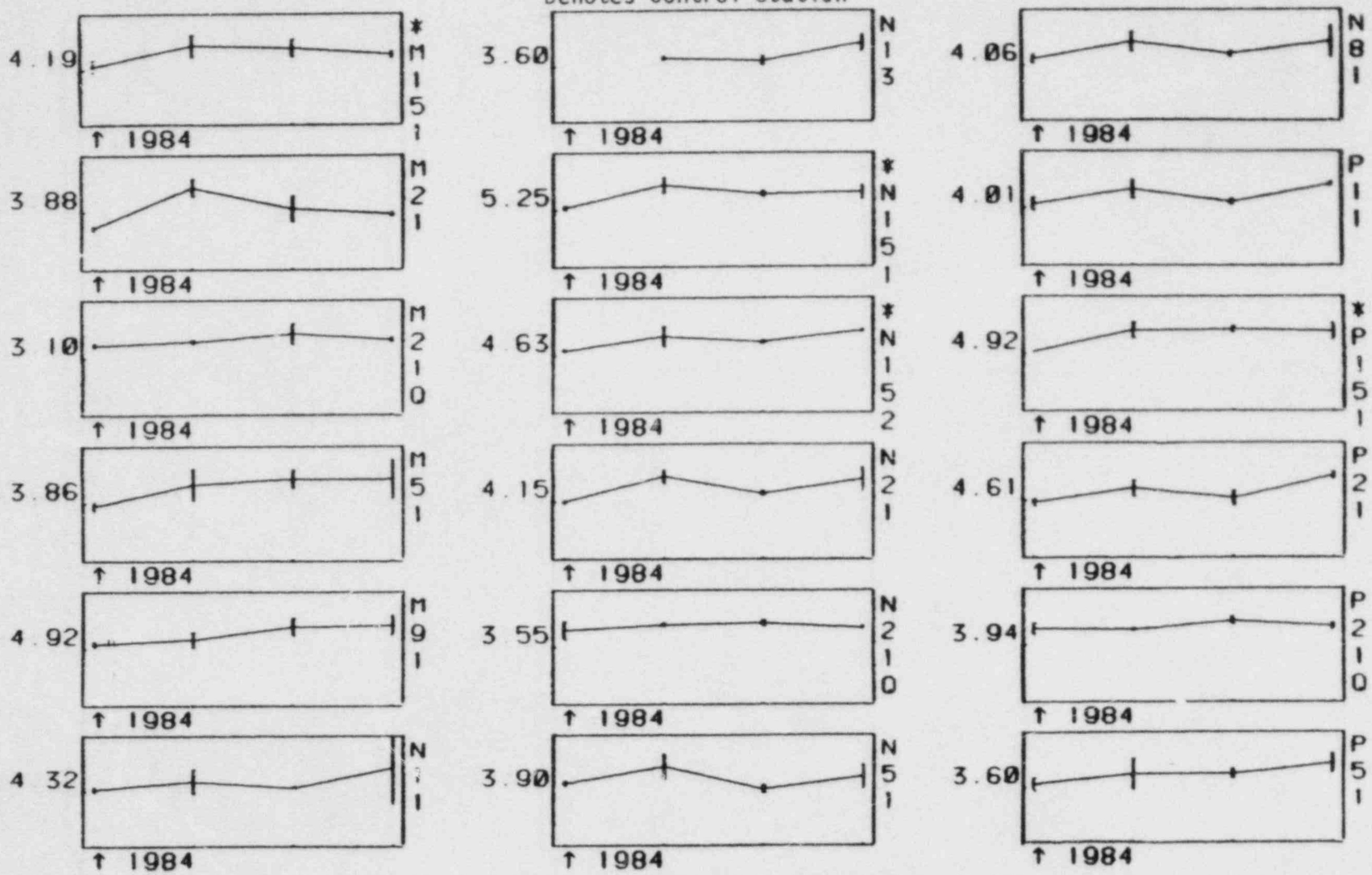


FIGURE M-1

TLD DATA
GRAPHS OF STATIONS
1984
Horizontal Axis-Quarters
Vertical Axis-mrem/Std. Mo.
*Denotes Control Station

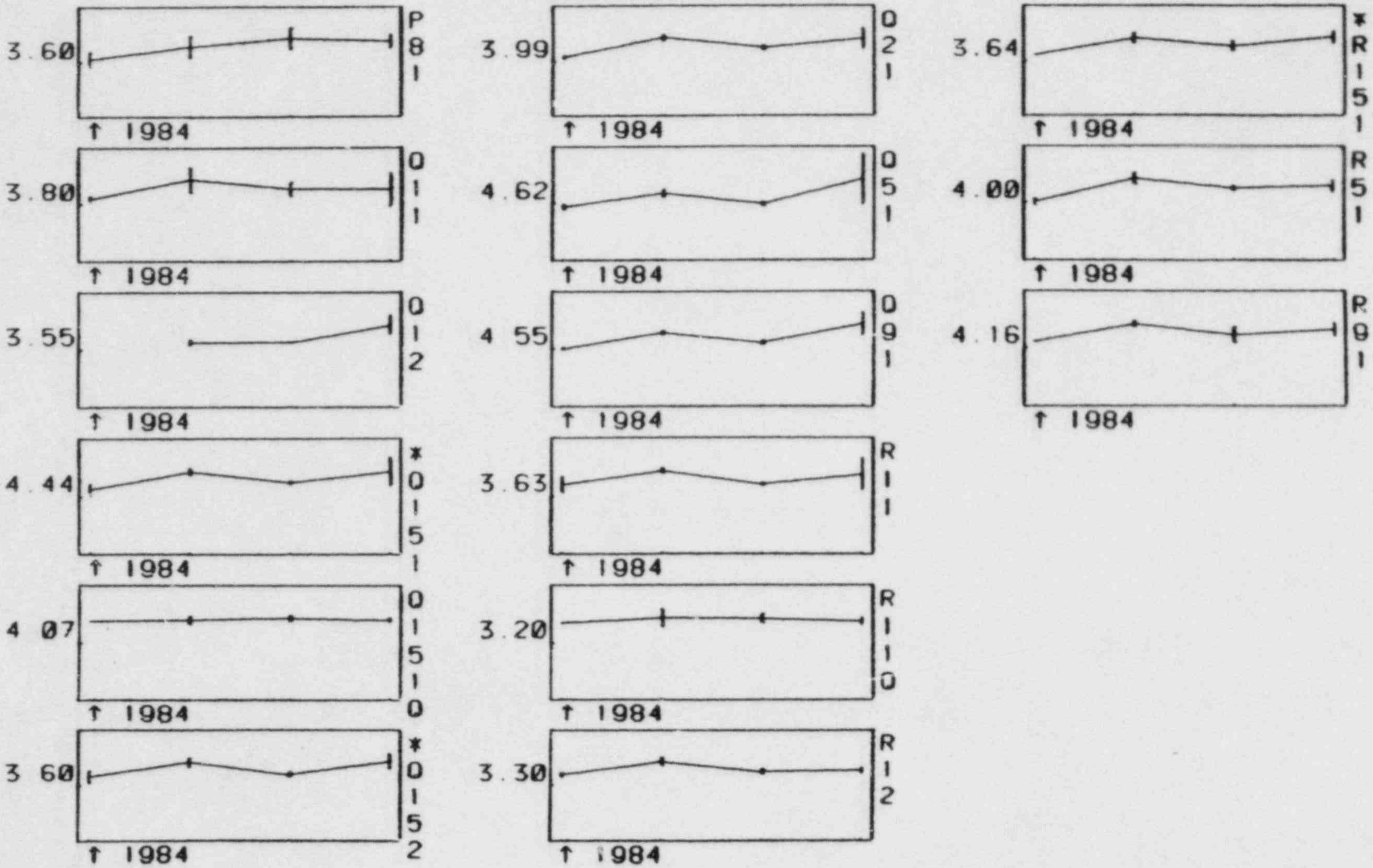
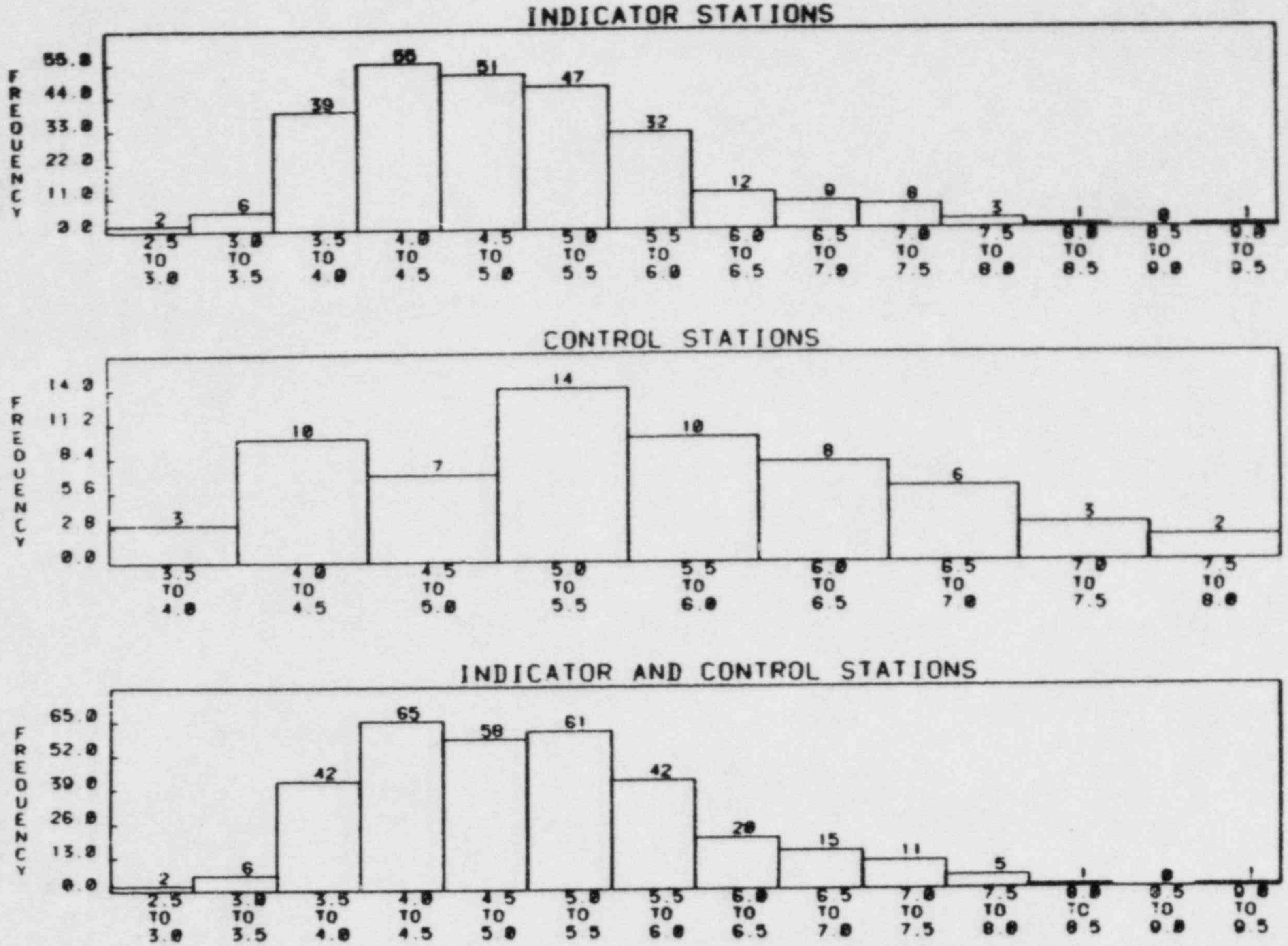


FIGURE M-2

FREQUENCY DISTRIBUTION FOR TLDS 1984

HORIZONTAL AXIS IN MREM PER STANDARD MONTH



APPENDIX N

Data Analysis

TMI Environmental Controls used a computer statistical analysis package (SAS) developed by SAS Institute, Inc. to analyze the 1984 REMP data. A sequence of tests was performed on each data set, with subsets created from the original data as required. Although the outputs are not presented in this report, this appendix describes the sequence and the purpose of each statistical test. The tests included:

- o Tests on the distribution of the data
- o Comparisons between control and indicator groups
- o Spacial and temporal comparisons between stations
- o Station correlations
- o Background and indicator group correlations

Quality Control (QC) results were not analyzed with other data. QC data would introduce bias at selected stations while providing little additional interpretive information. Significance was tested at the 95 percent confidence level ($P \leq 0.05$) for all data comparisons.

Parametric statistics were used whenever possible since they normally provide more power than the non-parametric equivalents. However, one of the basic assumptions of parametric statistics is that the data are normally distributed. To test for normality, and therefore choose the appropriate test, the UNIVARIATE procedure of SAS was used. This procedure tests the data against a normally distributed data set. Acceptance of the null hypothesis at the $P \leq 0.05$ level meant the particular 1984 REMP data set was normally distributed. Data that were not normally distributed were transformed by taking the natural log of the sample result plus 1 ($Y' = \ln(Y + 1)$) as described by Sokal and Rohlf (1969). If transformation resulted in normally distributed data, parametric statistics were used for data analysis. If neither the original data nor the log transformed data were normally distributed, non-parametric statistics were used to further analysis the data.

After determining the distribution, the data was grouped into the indicator and control subsets and tested for significant differences. If either the data or log transformed data were normally distributed, the TTEST procedure (SAS) was applied. Data that were not normally distributed were statistically compared using the NPAR1WAY procedure (SAS), a non-parametric analysis of variance. Acceptance of the null hypothesis at the $P \leq 0.05$ level indicated that there was no difference between control and indicator station groups.

Differences between stations were tested with the GLM procedure (normal data) and the NPAR1WAY procedure. The GLM procedure (SAS) performs an analysis of variance on unbalanced data (unequal sample sizes). Although not quite as powerful as the ANOVA procedure (SAS), the protocal of treating LLDs as missing data made GLM the appropriate choice. As with indicator vs control group comparisons, NPAR1WAY was performed on data sets that were not normally distributed.

When the results of GLM or NPAR1WAY indicated initial differences between stations, TMI-EC applied the DUNCAN multiple range test (SAS). The DUNCAN test compares each station with he others and identifies groups of stations with similar means.

Finally, correlation coefficients were calculated between both indicator and control group means and between station means with the CORR procedure (SAS). Correlation coefficients, based on the Pearson product-moment test for this report, may range from zero with no correlation to 100 percent with complete correlation. By comparing indicators to controls, a degree of association was identified for the year. Likewise, the amount of association between any two stations also was established.

Not every data set from the 1984 REMP collections was analyzed with the procedures listed above. Data sets with few observations could not be statistically compared. Rather, indicator and control values were compared to environmental levels expected outside the TMINS zone of impact. Other factors considered for non-statistical comparison of data included data collected by other scientists and known levels of radioisotopes resulting from non-TMI sources (i.e., hospitals and weapons tests). Otherwise, when data sets permitted, statistical analyses of the data followed the sequence of tests described above.

GPU Nuclear

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Writer's Direct Dial Number:

April 30, 1985
5211-85-2075
4410-85-L-0081

Dr. Thomas E. Murley
Region I, Regional Administrator
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, Pa. 19406

Dear Dr. Murley:

Three Mile Island Nuclear Station, Units 1 and 2 (TMI-1 & TMI-2)
Operating License No. DPR-50 and DPR-73
Docket No. 50-289 and 50-320
1984 Radiological Environmental Monitoring Report

In accordance with the requirements of TMI-1 and TMI-2 Technical Specifications, enclosed are copies of the TMINS 1984 Annual Radiological Environmental Monitoring Report.

Sincerely,

R. W. Heward, Jr.
Vice President and Director
Radiological & Environmental Controls

RWH/JGB/spb

Attachments

cc: R. Conte
H. Denton
B. J. Snyder
J. Thoma
Document Control Desk (2 copies)

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